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Appendix K
Water Quality Monitoring

APPENDIX K

Water Quality Monitoring
Pre-Design Field Test Dredge Technology Evaluation Report
New Bedford Harbor Superfund Site

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K.1 INTRODUCTION

The Pre-Design Field Test was undertaken to evaluate the performance of a dredge system being considered for use at the New Bedford Harbor Superfund Site. The objectives of the Pre-Design Field Test included: 1) evaluating actual dredge performance relative to removal of contaminated sediments; 2) evaluating the dredge's ability to minimize environmental impact to water quality by measuring the extent of contaminated sediment resuspension and transport; and 3) evaluating the dredge's ability to operate within acceptable air quality levels. The technology selected for the study was a hydraulic excavator equipped with a slurry-processing unit (provided and operated by Bean Environmental, LLC). The field test was performed in August 2000 in a 100-foot by 550-foot (30.5 x 168m) area within New Bedford's Upper Harbor (Figures K-1, K-2).

This appendix evaluates water quality impacts associated with the Pre-Design Field Test and includes the following components:

- Predictive modeling used to aid in the design of the water quality monitoring field program and to assess the utility of modeling for the full-scale remediation effort;
- Field monitoring to assess sediment resuspension during the dredging operation, to collect water samples for laboratory analysis, and to ground-truth the predictive modeling;
- Laboratory analysis of water samples (TSS, PCBs) to assess water quality impacts; and
- Correlation assessment between the field and laboratory data.

The predictive modeling included development of a numerical hydrodynamic and sediment transport model based on previous work in New Bedford Harbor (USACE, 1998 and 2000). Modeling was used to predict the expected suspended sediment concentration resulting from dredging activities under a variety of transport assumptions. These predictions were used to help design the field monitoring program.

Field monitoring was performed in parallel with the dredging activities in August 2000. Objectives of the monitoring included real-time location and mapping of any turbidity plume associated with the dredging as well as collection of water samples at designated stations downstream of the dredge for laboratory analysis. The monitoring program was structured to document water column conditions in the Upper Harbor over the course of ebb and flood tidal events during dredging operations. Water samples were analyzed for total suspended solids (TSS) and dissolved and particulate PCBs. An assessment of the correlation between field turbidity as measured by an optical backscatter sensor and laboratory TSS data was performed. In addition, the laboratory TSS data were compared to PCB concentrations.

This appendix represents a joint effort by the U.S. EPA, the U.S. Army Corps of Engineers (USACE, New England District), and ENSR International (under contract DACW 33-96-D-004 to the USACE).

K.2 PREDICTIVE NUMERICAL MODELING

A numerical model of Upper New Bedford Harbor was developed and applied to predict concentrations of suspended sediment in the water column resulting from dredging activities. The predictions were used in the initial design of the water quality field-sampling program for the Pre-Design Field Test. Subsequent to the Field Test, the accuracy of the model was assessed to evaluate its efficacy as a predictive tool for monitoring during full-scale remediation at the site. The model was based on previous hydrodynamic modeling of New Bedford Harbor performed by the U.S. Army Corps of Engineers (USACE, 1998 and 2000). The computer models RMA2 and SED2D were used to simulate hydrodynamics and sediment transport, respectively (USACE, 1997 and Letter *et al.*, 1998).

K.2.1 Methods

Hydrodynamic Model

RMA2 is a two-dimensional depth-averaged finite element model that simulates free surface flow (USACE, 1997). The present application of the model builds on previous modeling carried out in 1988 and early 2000 (USACE, 1998 and 2000). The domain and model mesh, as revised for this effort, is shown in Figure K-3. The domain covers the upper portion of New Bedford Harbor from the Coggeshall Bridge at the south, to the Wood Street Bridge at the north. The mesh size ranged from 30 meters (98 feet) over most of the domain to 5 meters (16 feet) in the vicinity of the dredging area. This finer mesh provided the level of detail required to simulate sediment transport.

The hydrodynamics model RMA2 was applied to New Bedford Harbor in 1988 and was calibrated to two sets of conditions; a spring high tide, corresponding to conditions measured in March 1986, and a tide between mean high tide and mean spring tide measured in April 1986 (USACE, 1998). The 1988 model was rerun in early 2000 to study the potential impact of confined disposal facility construction on the hydrodynamics of New Bedford Harbor (USACE, 2000). The 1988 and 2000 model was used in the present study to provide boundary conditions for the Upper New Bedford Harbor model. The predicted water surface elevation at the Coggeshall Bridge was used to drive the new Upper New Bedford Harbor hydrodynamic model at the southern boundary, while the same freshwater inflow used in the initial model was used at the northern boundary.

Sediment Transport Model

The SED2D model was used to simulate sediment transport resulting from dredging activities. The model calculates suspended sediment concentration and change in bed elevation (Letter *et al*, 1998). Under the normal range of environmental conditions in the Upper Harbor, waves, tidal currents, and precipitation runoff can cause resuspension of sediments. However, for the present application, it was assumed that the bed-surface was non-erodible; therefore, the only sediment source was that resulting from dredging operations. This allowed for a clearer presentation of the potential suspended solids impacts of dredging.

The sediment source was defined as a constant input mass rate of sediment released in the water column at four mesh elements. The resolution of the model mesh in the dredging area is roughly 5 m (16 feet) square. The source was assumed to cover an area of four mesh elements at any time, an area approximately equal to that of the dredge moon pool (10 m x 10 m) (33 feet x 33 feet). The source strength was estimated from the expected production rate of 69 m^3/hr (90 yd^3/hr), and from Bean's assessment of the fraction of sediment lost to the water column by the environmental bucket used. Bean estimated the fraction lost to no more than 1%. Combining the production rate and the percent loss, the total sediment release rate to the water column was calculated to be approximately 482 kg/hr (1063 lb/hr).

The sediments were assumed to be composed of 3 main sediment fractions presented in Table K.2-1 and are based on grain size data presented in the work plan for the Pre-Design Field Test (FWENC, 2000). All three fractions were assumed to be non-cohesive with fall velocities calculated using Stokes equation. Since the SED2D model can only simulate one sediment type at a time, each fraction was run independently, and the results were combined to obtain the total suspended solids concentration.

Table K.2-1: Sediment Characteristics

Fraction Name	Fraction by weight (%)	Mass Release Rate (kg/hr)	Representative grain diameter (mm)	Fall velocity from Stokes equation[1] (m/s)	Comments
Sand	19%	91.5	2.0	3.21	Corresponds to the middle of the "fine sand" classification (ASTM, 1990).
Silt	53%	255.2	0.02	3.21×10^{-4}	Corresponds to the middle of the "silt" classification (ASTM, 1990).
Clay	28%	134.8	0.002	3.21×10^{-6}	Corresponds to the middle of the "clay" classification (ASTM, 1990).

[1] Fall velocity is calculated using Stokes equation $\omega = gd^2(\rho s-\rho)/18\mu$, where g is the gravitational acceleration (9.81 m/s^2), d is the diameter of a spherical grain (m), ρs is the density of sediment particles (kg/m^3), ρ is the density of water (kg/m^3), and μ is the dynamic viscosity of water ($N\text{-}s/m^2$). A dry density of 700 kg/m^3 was assumed for all sediments. Water density and viscosity were respectively taken as 999 kg/m3 and $1.12E^{-3}$ Ns/m^2 for fresh water at 15.6°C. Note that the Stokes equation assumes that sediments settle as discrete particles. For fine particles, a better estimate of the fall velocity would be obtained through laboratory measurements. In the current application, Stokes equation was assumed to provide a suitable estimate of the fall velocity.

Model Parameters and Variables

Transport in surface water systems is highly dependent on the dispersion coefficient, a parameter that determines the extent of "spreading" of a transported substance under ambient flow conditions. Typical literature values for dispersion coefficients vary widely and are usually determined by calibrating the model to field measurements. In the absence of field measurements to calibrate the present model, a series of simulations were performed with dispersion coefficient values of 0.1, 1.0, 10 and 100 m^2/s (1, 11, 108, 1076 ft^2/s). As expected, the dispersion coefficient had a major impact on the extent of the suspended sediment plume and predicted concentrations. Comparison of model predictions with field data collected in August 2000 during the Pre-Design Field Test is presented in Section K.6.3.

K.2.2 Results

The Upper New Bedford Harbor model was used to predict suspended sediment concentrations (above background) resulting from dredging activities. The model was run with a constant sediment source at the point of dredging for two tide cycles, and the results for each sediment fraction were combined to predict the total suspended sediment concentration throughout Upper New Bedford Harbor at ½ hour intervals. Figures K-4 and K-5 present an example of modeled suspended sediment concentrations during flood tide and ebb tide, respectively. Figure K-6 presents a time series of predicted suspended sediment concentration at specified distances north and south of the dredge, along with water surface elevation at the Coggeshall Street Bridge. The three figures present results of a simulation for which the dredge was situated in cut #1 of the dredging area (see Figure K-2 for location), and the dispersion coefficient was set to 10 m^2/s (108 ft^2/s).

Numerous scenarios were considered with different combinations of dredge location within the test area, mass release rate, and dispersion coefficients. Predicted local TSS concentrations were greatest when the dredge was in the shallower waters at the eastern end of the test area; however, far-field TSS levels were similar to those levels predicted to be present when dredging in deeper waters. The peak concentration predicted (immediately adjacent to the sediment release/dredge location) decreased with increasing dispersion coefficients and varied from a maximum of about 390 mg/L for dispersion coefficient of 0.1 m^2/s (1 ft^2/s), to less than 5 mg/L for a coefficient of 100 m^2/s (1076 ft^2/s). The later value is within the variability of background measurements; therefore, it is difficult to detect above ambient conditions. Table K.2-2 presents the peak suspended sediment concentration predicted for different dispersion coefficient values. In all cases, the results predicted no re-suspended sediment transport under the Coggeshall Street Bridge to the Lower Harbor while the dredge operated within the designated Pre-Design Field Test area. A comparison of the model predictions and field measurements is presented in Section K.6.3.

Table K.2-2: Impact of Dispersion Coefficient on Predicted Peak Concentration and Length of Suspended Sediment Plume.

Dispersion coefficient (m^2/s)	Peak suspended sediment concentration in immediate vicinity of dredge (mg/L) – above ambient conditions	Approximate length of plume at 5 mg/L contour (m)
0.1	390	900
1.0	72	800
10	13	120
100	2	0

K.3 METHODS FOR MONITORING THE PRE-DESIGN EFFORT

K.3.1 Navigation and Positioning

The environmental monitoring program was conducted using the 19' survey vessel *Cobia* and the 35' support vessel *Sakonnet*, leased from, and operated by CR Environmental, Inc. The *Sakonnet* was anchored in the lower part of the estuary near the USACE Sawyer Street Project Office and served as the platform for staging the monitoring effort. The *Cobia* served as the mobile survey platform and was equipped with a Trimble Pro-XRS GPS system to achieve real-time sub-meter accuracy. The output of the Trimble GPS system was integrated into HYPACK; a PC-based software package which displays navigational information and electronic sensor data on a digital base map of the survey area. The HYPACK system allowed the boat operator to view the actual vessel position relative to physical features including geographic landmarks and, more importantly, the outline boundaries of the 100-foot x 550-foot (30.5 x 168 m) test area. The system has the added capability of storing waypoint information; this feature enabled the boat operator to mark and revisit sampling stations or points of interest during the study to ensure that composite samples were collected at the same location.

K.3.2 Characterizing Current / Tidal Profiles in the Upper Harbor

Current and tidal profile measurements needed to confirm the accuracy of the numerical model predictions presented in Section K.2 were performed using a Nortek Aquadopp current meter. The sensor operates by measuring the Doppler shift of an acoustic signal transmitted into the water column that is reflected off suspended material carried in the flow field. The unit consists of three acoustic heads, two positioned roughly parallel to the horizon (separated by an angle of 45 degrees) and a third centered between these two oriented up at a 45 degree angle from the horizon. Each head transmits a narrow beam signal and detects the frequency shift in the parent signal caused by particles passing parallel to the beam. The individual contribution made by the three sensor heads allows the unit to resolve the 3-D velocity of the flow field; an internal magnetic compass enables the unit to convert XYZ velocity into the east-north-up (ENU) vector. The Aquadopp unit is also equipped with a pressure sensor to record the hydrostatic head (converted to water depth) over the top of the sensor package, as well as a water temperature sensor.

The unit was mounted in a stainless steel frame and placed on the harbor bottom approximately 1500 feet (457 m) south of the dredge evaluation area. Water velocity measurements were made every 10 minutes during the course of the eight-day deployment (11 August to 18 August 2000).

K.3.3 Measurement of Water Column Turbidity

Water column turbidity measurements were performed using an optical backscatter sensor (OBS). The OBS sensor used for this effort was the OBS-3 sensor with a range of 0-2000 Nephelometric Turbidity Units (NTU) manufactured by D&A Instruments of Port Townsend, WA. The OBS sensor is a mini-nephelometer that operates by flashing a parcel of water with an optical signal, then measuring the infrared radiation scattered back to the sensor by suspended particles and displaying the output in NTUs. The sensor was fixed to an adjustable vertical mount that allowed it to be positioned to a constant depth of 18, 24, 30, or 36 inches (46, 61, 76 or 91 cm) while collecting transect data. The sensor could also be removed for deeper measurements. A sampling depth of 24 or 30 inches (61 or 76 cm) was used for most of the transects located in the shallow water of the estuary surrounding the test area. This sensor depth resulted in data collection near the midpoint of the water column in the deepest areas along the center of the channel.

Turbidity monitoring was initiated prior to the start of dredging operations in order to characterize baseline turbidity conditions within the Upper Harbor. After dredging began, the water quality conditions were closely monitored to assess the development and the areal extent of any elevations of turbidity from baseline conditions. The results of the model predictions presented above in Section K.2 were used to set target distances for the initial transects (locations where an elevation of turbidity was expected). This initial turbidity tracking was conducted for one hour after the start of active production dredging, after which the positions of down-current stations were set for collecting TSS and PCB samples. Turbidity data continued to be collected in the Upper Harbor during each monitoring event, and selective east-west or north-south transects were performed to document changing water column conditions.

K.3.4 Sample Collection for TSS and PCB Analyses

Sampling for TSS and PCB analyses was performed over four discrete tidal events (ebb/flood on 16 August and ebb/flood on 17 August) while dredging operations were ongoing. The predicted tide change (based on NOAA tables) was confirmed by the change in current direction indicated by movement of a drogue buoy. The track of the drogue buoy down current of the dredge also provided insights into the potential site-specific path for plume migration. Turbidity mapping was performed for the first hour of each event to track the development of any plume and to aid in setting sampling station locations. The data from the turbidity transects were compared with the initial station locations (based on model predictions), and the locations of the down-current stations were finalized. For the monitoring performed on 16 August, stations were set at 50 feet, 100 feet, and 500 feet (15, 30 and 152 m) down current of the dredging and 1000 feet (305 m) up-current. The up-current station was considered a reference station. Because elevated turbidity readings were noted down current beyond the sampling stations on 16 August (although the elevations were most likely due to rainfall run off and not dredging), an additional down-current station was added for the 17 August monitoring. Stations were set at 50 feet, 300 feet, 700 feet, and 1000 feet (15, 91, 213 and 305 m) down current of the dredging.

Consecutive hourly sampling was performed at each station during the course of the monitored tidal event, provided dredging activities were sustained. The hourly samples were combined to form an “event composite” for each station. The number of samples included in the composites ranged from two to four depending on the dredging schedule for a given monitoring event. Water samples were collected from designated stations using a 12-volt diaphragm pump equipped with fluoropolymer tubing. The tubing inlet was placed alongside the OBS sensor to match the water samples collected for TSS analysis with turbidity measurements. In general, samples were collected from approximately mid-water column after flushing the pump and tubing with a minimum of 3-volumes of ambient station water. The specific protocols applied during the collection of TSS and PCB samples in the field are detailed in the QAPP (ENSR, 2000).

In addition to the composite samples, the following discreet samples were collected as part of the monitoring:

- Reference samples were collected for analysis of PCBs and TSS prior to the start of the Pre-Design Field Test (7 August) and prior to the start of dredging on each monitoring day (16-18 August).

- Specific events of interest were sampled for PCBs. These included a surface oil sheen noted on 16 August, the plume associated with positioning of the support vessel *Miami II* on 17 August, and a moonpool sample on 18 August.

- The discreet samples taken at the same location and time as the samples used to build the event composites were also analyzed individually for TSS to assess the relationship between turbidity and TSS.

K.3.5 Laboratory Analysis

Dissolved and Particulate PCBs

Water quality samples collected for PCB analysis were transferred to Woods Hold Group (Raynham, MA) for initial sample filtering to separate the dissolved and particulate PCB fractions. Samples were filtered within 24 hours using glass fiber filters as specified in the QAPP (ENSR, 2000). Soluble PCB fractions were stored at 4°C, and particulate fractions were stored frozen until further processing and analysis. Two laboratories supported ENSR analytically; Woods Hole Group (Raynham, MA) was selected as the primary laboratory, and Arthur D. Little (Cambridge, MA) participated as the backup/QA laboratory.

The 18 PCB congeners selected by NOAA for the National Status and Trends program and by the EPA EMAP program were selected for analysis in this study. The preparation methods used to generate these data were selected to match those used by previous investigators and are detailed in the project QAPP (ENSR 2000). Dissolved PCB fractions were extracted using methylene chloride, reduced in volume and exchanged into hexane, cleaned with sulfuric acid and analyzed using gas chromatography/electron capture detection (GC/ECD) for the 18 target congeners. Particulate fractions were treated in a similar manner but included a maceration step using stainless steel homogenizing cutting blades (Tissuemizer).

The compounds dibromo-octafluoro-biphenyl (DBOFB) and PCB-198 were added to all samples as surrogate internal standards (SIS) and carried through the sample preparation and analysis process as a measure of accuracy. The Pre-Design Field Test water quality data sets were SIS corrected using PCB-198 for consistency with earlier water quality investigations. Final (hexane) extracts were analyzed using a single chromatographic column to speed data delivery and provide comparability with earlier New Bedford Harbor aqueous PCB investigations.

The congener data were summed to simplify comparisons between stations. This sum represents only the 18 NOAA PCB congeners and has no relation to total PCBs as homologues or Arochlors. The relationship for converting PCB congener to total PCB as homologues developed for this project (FWENC 2000) is for sediments and cannot be applied to aqueous measurements.

Total Suspended Solids

Water samples collected for the total suspended solids (TSS) analyses were transferred to Woods Hole Group (Raynham, MA) for filtration and analysis. Samples were filtered using membrane filters, rinsed with buffered deionized water to remove salts before desiccating and submitting for gravimetric TSS analysis as specified in the QAPP (ENSR, 2000). Woods Hole Group performed all of the TSS measurements.

Quality Assurance

The laboratory data was validated by ENSR's QA department and included the following review elements as described in the Quality Assurance Project Plan (QAPP; ENSR, 2000):

- Analytical completeness (agreement with chain-of-custody and project requirements);
- Sample preservation and holding times;
- Instrument initial and continuing calibration information;
- Laboratory method blank/equipment blank contamination;
- Surrogate spike recoveries;
- Matrix spike/matrix spike duplicate (MS/MSD) results;
- Laboratory control sample (LCS) results;
- Internal standard performance; and
- Quantitation limits.

The validation was used to potentially qualify or reject sample or individual congener data that did not meet the data quality objectives established in the QAPP (ENSR, 2000).

Equipment blanks were collected twice during the field effort. Blanks were collected at the end of the day after the investigative sampling effort was complete and after the system was rinsed with tap and deionized water. First, the pump inlet tube was placed in a reservoir of tap water and approximately four liters were pumped through the system. Next, the pump inlet tube was placed in deionized water (DIW), three liters of DIW were flushed through the system, and the fourth liter was collected for analysis.

K.4 CHRONOLOGY OF WATER QUALITY MONITORING

The chronology of water quality monitoring is summarized in Table K.4-1. A series of dredge equipment and operational modifications during the first six days of dredging (10-15 August) resulted in limited periods of continuous dredging each day. As a result, turbidity monitoring was performed during part of the day, but monitoring/sample collection over a full ebb or flood tide could not be performed. Dredge operations were much more continuous on 16-17 August, and both ebb and flood tide monitoring events were performed each day.

Table K.4-1 Chronology of Water Quality Monitoring

Date	Dredging Operations	Field Monitoring
Friday, 04 August	Assembly and testing. Dredging start tentatively set for 08 August.	Mobilization of field equipment completed in New Bedford.
Monday, 07 August	Final assembly and testing of dredge platform continues. Start of actual dredging operations is rescheduled for 10 August.	Field testing of monitoring and sampling equipment. Pre-dredge baseline water quality samples were collected.
Thursday, 10 August	Dredging operations begin in cut #6. Operational difficulties encountered with the handling of sediments containing significant quantities of embedded shells	Turbidity monitoring only. No formal sampling events were performed due to the limited period of dredging.
Friday, 11 August	Dredging operations continue in cut #6. Operational difficulties continue to limit the periods of continuous dredging.	Turbidity monitoring only. No formal sampling events were performed due to limited period of dredging. Current meter programmed and deployed.
Saturday, 12 August	Dredging operations continue in cut #6. Operational difficulties continue. Dredging operations are suspended to initiate equipment and operational modifications to improve dredge performance.	Turbidity monitoring only. No formal sampling events were performed due to limited period of dredging. Water quality monitoring discontinued during the dredge modification period with the understanding that the dredge would only operate in the eastern half of the test area.
Sunday, 13 August	Dredging operations resume in cut #6.	No monitoring performed.
Monday, 14 August	Dredging operations continue in cuts #7 and #8.	No monitoring performed.
Tuesday, 15 August	Dredging operations completed in cut #8. Dredge shifted to cut #5.	Continuity of dredging is insufficient to support a full sampling event. Turbidity monitoring with grab samples collected for TSS analysis.
Wednesday, 16 August	Dredging operations completed in cut #5 and later in cut #4. Dredge shifted to cut #3.	One EBB and one FLOOD tide sampling event completed.
Thursday, 17 August	Dredging operations completed in cut #3 and later in cut #2. Dredge shifted to cut #1.	One EBB and one FLOOD tide sampling event completed.
Friday, 18 August	Dredging operations completed in cut #1. Operational difficulties resulted in reduced rate of dredging. Dredge shifted into the provisional test area and operated for one set in cut A. The dredging operations as part of the Pre-Design Evaluation were concluded. Demobilization of equipment begins.	Continuity of dredging is insufficient to support an additional full sampling event. Turbidity monitoring and collection of grab samples for TSS and PCB analysis. Demobilization of equipment begins. Current meter recovered.

K.5 MONITORING RESULTS FOR THE PRE-DESIGN EFFORT

K.5.1 Tidal and Current Data

Measurements of current velocity and tidal elevations were obtained using a Nortek Aquadopp current meter as outlined in Section K.3.2. The unit was mounted in a stainless steel tripod frame and lowered to the bottom of the harbor at a point approximately 1500 feet (457 m) south of the dredge evaluation area. The height of the sensor over the bottom was approximately 3.5 feet (1.1 m), and the current measurements were then performed on a water parcel approximately 3.5 to 4.5 feet (1.1-1.4 m) above the bottom. This measurement depth was generally representative of the middle portion of the water column (the total water depth ranged from approximately 7 feet (2 m) at low tide to 10.5 feet (3.2 m) at high tide at this location.

Figure K-7 presents current and water depth data that were obtained from the Nortek unit. As would be expected from the geographic orientation of the Upper Harbor, the principal velocity component (V_y) is approximately oriented along the north-south axis of the Harbor. From 12-14 August, the northerly component of velocity peaked at 12 to 14 cm/sec (0.4 –.0.5 ft/sec) during the early to mid portion of the flood tide. A limited southerly component of current was detected for the mid-water column over the ebb tide, indicating a stratified flow system (the lower portion of the water column moving south with the ebb tide while the middle/upper portion remained more stagnant). From 15-18 August (including the water quality monitoring period), a reversing north-south current was recorded, but the northerly component was generally greater in magnitude and longer in duration than the southerly component.

The current velocity component across the Upper Harbor (V_x), (current aligned in the east-west direction) was significantly smaller than V_y, with magnitudes of less than 5 cm/sec (0.2 ft/s) and generally moving towards the east on both the ebb and flood tide. A measurable component of vertical current (V_z) was also observed with variations that generally correlated with the tidal cycle.

The data presented in Figure K-7 indicate that the hydraulics of the Upper Harbor were influenced by wind forces aligned along the north-south axis of the estuary. For the period of 12 August through 15 August, the wind velocity recorded at the Sawyer Street site had a southerly component (see notes along x-axis in Figure K-7). The V_y current measured during this period generally remained positive (or directed to the north) throughout the tidal cycle, implying that a wind-generated counter current existed during the ebb (southerly moving) portion of the tide. This condition persisted until the arrival of a frontal system late on 15-16 August with an accompanying shift in wind direction. As winds with a southerly component (blowing towards the North) are a common summer feature, this three-dimensional flow regime is expected to occur on a regular basis.

Figure K-8 presents the relationship between three independent records for the tidal elevations in New Bedford Harbor. Data shown on the tidal sinusoid were predicted by: 1) computer software for the harmonic tide station in New Bedford Harbor, 2) the hydraulic head recorded above the Nortek sensor package, and 3) visual measurements recorded from a surveyed tide staff installed along the banks of the estuary at the dredge area. Figure K-8 indicates that the three tidal elevation data sets are generally in agreement along the timeline of the recording period. It should be noted that the elevation recorded by the Nortek sensor is an indication of the height of the water column above the sensor. The tidal range and period measured by the sensor can be compared with the other measurements/predictions. However, the actual elevation should be considered approximate, as the exact height of the sensor above the bottom was not measured.

Comparison of the predicted and measured tidal sinusoids in Figure K-8 reveals a small timing delay between the measurements in the Upper Harbor and the predictions for the harmonic tide station positioned in the Lower Harbor. In addition, the actual measured tidal elevation in the Upper Harbor varied occasionally from the predictions by values less than 0.5 feet (0.2 m). Both of these offsets (time and elevation) are expected given the hydraulic constriction between the Upper and Lower Harbor (I-195 and Coggeshall St. bridges) and the potential for weather impacts on actual tidal levels (not considered in the predictions).

K.5.2 Turbidity Measurements

Detailed turbidity measurements were performed during dredging operations on 16-18 August, and the results are presented below and summarized in Figures K-9 through K-19. Figure K-20 depicts the instrument setup for the turbidity measurements. The reference turbidity values (measured outside of the influence of the dredging operation) often varied significantly over the course of a monitoring effort due to normal environmental influences, i.e. tide, wind, and rainfall runoff. Hence, all values reported below and in the accompanying figures are actual measured values unless specifically noted as "turbidity excursions above background."

Event Number 1 - Ebb Tide Monitoring 16 August

Monitoring was performed during the morning/afternoon ebb tide on 16 August. The predicted tides for New Bedford Harbor (NOAA) for this period were a 0927 high and a 1440 low. A reference sample was collected prior to the start of dredging at 0920, approximately 1000 feet (305 m) north of the dredging operation. Start up of dredging was delayed until almost 1100 due to thunderstorms in the area. Rainfall in the area varied with some isolated heavy squalls. Monitoring resumed from 1110 to the end of the ebb tide with samples collected over a two-hour period. Dredging operations were completed in cut #5 at approximately 1130. The dredge was then relocated to cut #4 for the remainder of the ebb tide monitoring period. According to the operational logs, a combined total of 2-hours 50-minutes of active dredging was accomplished during this tidal event.

Turbidity measurements performed during the monitoring event are presented on Figures K-9 and K-10. The floating discharge pipeline from the dredge prevented transects from being run across the entire width of the harbor down current of the dredge. Consequently, separate sets of measurements were performed to the east and to the west of the pipeline.

Sensor data indicate that the up-current (background) values during the monitoring period were 12 NTU or less approximately 1000 feet (305 m) up-current from the dredging operation. Down-current turbidity data peaked at 61 NTU approximately 250 feet (76 m) from the dredge. This peak is attributed to dredge repositioning and support vessel operations rather than actual dredging (based on the timing and locations of the peaks). Typical down-current turbidity values ranged from 14 to 35 NTU, representing excursions over background of 25 NTU or less (within 500 feet (152 m) down current of the dredge). An easterly component to the ebb tide current resulted in the turbidity excursions being located on the eastern side of the Upper Harbor.

Event Number 2 - Flood Tide Monitoring 16 August

Monitoring was performed during the afternoon/evening flood tide on 16 August. The predicted tides for New Bedford Harbor (NOAA) for the period were a 1440 low and a 2143 high. Monitoring was performed from 1530 to 1941. The dredge was shut down for maintenance for nearly an hour early in the flood tide cycle. As a result, initiation of sample collection was delayed until dredging resumed. Water samples were collected over a two-hour period beginning at approximately 1700. Dredging operations were completed in cut #4 at approximately 1645. The dredge was then relocated to cut #3 for the remainder of the flood tide monitoring period. According to operational logs, a combined total of 2-hours 34-minutes of active dredging was accomplished during this tidal event.

Turbidity measurements made during this monitoring event are presented on Figures K-11 through K-13. Sensor data indicate that the background values were initially in the range of 6 to 15 NTU (approximately 1000 feet (305 m) up current of the dredge operation). During the second hour of sampling, reference values were significantly higher, ranging from 38 to 48 NTU. Transects performed further south (up to 2000 feet (610 m) up current of the dredge operation) identified turbidity values as high as 192 NTU (Figure K-12). This elevated background turbidity was attributed to the inflow of storm water runoff as a result of the heavy rain that occurred earlier in the day. The run-off may have been discharged into the Upper Harbor directly, or discharged into the Lower Harbor and then transported north with the flood tide. Waters within the Upper Harbor were visibly cloudy later in the flood tidal cycle, beginning in the south (up current of the dredge operation) and then moving north with the flood tide.

Typical down-current turbidity values were in the range of 18 to 89 NTU, representing excursions over background of 50 NTU or less. Intermittent higher spikes above 100 NTU were also recorded, with a peak value of 202 NTU. Based on the timing and observations of the dredge activity, these elevated values were attributed to dredge repositioning and support vessel operations rather than the dredging activity itself.

Dredging activity was completed for the day at 1906. A transect performed at 1930 extending from approximately 1500 feet (457 m) up current of the test area to 1500 feet (457 m) down current revealed a general elevated turbidity over the entire transect apparently unrelated to dredging with values generally ranging from 25 to 50 NTU (Figure K-13).

Event Number 3 - Ebb Tide Monitoring 17 August

Monitoring was performed during the morning/afternoon ebb tide on 17 August. The predicted tides for New Bedford Harbor (NOAA) for the period were a 1007 high and a 1518 low. A reference sample was collected just after the start of dredging at 1058, approximately 1000 feet (305 m) north of the dredging operations. Monitoring down current of the dredge began at 1107 and continued to the end of the ebb tide with water samples collected over a four-hour period. Dredging operations were completed in cut #3 at approximately 1220. The dredge was then relocated to cut #2 and dredging continued for the remainder of the ebb tide monitoring period and into the flood tide. According to operational logs, a combined total of 2-hours 59-minutes of active dredging was accomplished during this tidal event.

Turbidity measurements performed during the course of the monitoring event are presented on Figures K-14 through K-16. Turbidity at the reference station was elevated at the start of monitoring (23-27 NTU at 1058), but had dropped by the next set of measurements and ranged from 5 to 18 NTU over the remainder of the monitoring period. Turbidity values down current of the dredging operation were generally 25 NTU or less. A localized plume was identified in the wash of the *Miami II* as it maneuvered around the dredge with a peak turbidity measured at 101 NTU (Figure K-15). Elevated turbidity was measured later in the monitoring period at approximately 1530 down current of the dredge from approximately 200-500 ft (61-152 m) with values generally ranging from 50 to 100 NTU and a peak value of 111 NTU (Figure K-16). Based on the timing and position of these measurements, the elevated values are attributed to observed support vessel activity rather than the actual dredging.

Event Number 4 - Flood Tide Monitoring 17 August

Monitoring was performed during the afternoon/evening flood tide on 17 August. The predicted tides for New Bedford Harbor (NOAA) for the period were a 1518 low and a 2224 high. Monitoring was performed from 1530 to 1948, beginning with the reference station approximately 1000 feet (305 m) up current from the dredge. Water samples were collected over a three-hour period. Dredging operations were completed in cut #2 at approximately 1700. The dredge was then relocated to cut #1 for the remainder of the flood tide monitoring period. Dredging was completed for the day at 20:06. According to operational logs, a combined total of 3-hours 08-minutes of active dredging was accomplished during this tidal sampling event.

Turbidity measurements performed during the course of the monitoring event are presented on Figures K-17 through K-19. Turbidity measured at the reference station, approximately 1000 feet (305 m) up current from the dredge ranged from 4 to 13 NTU. Down-current turbidity values were generally well under 25 NTU (less than 10 NTU over background). Values of 60 to 70 NTU were observed during the sampling at station 3 at 1712 with an associated TSS of 210 mg/l. These elevated values are attributed to the earlier grounding of the support vessel *Miami II* to the east of the dredge (see Figure K-17 for location) and the subsequent efforts to free it.

Monitoring 18 August

A third ebb tide monitoring event was scheduled for 18 August to coincide with the predicted tide (1049 high to 1557 low). Operational constraints including pipe clogs necessitating backwashing, an electrical breakdown, and a computer problem aboard the dredge limited the extent of continuous dredging, and a formal monitoring event could not be performed. Turbidity monitoring was performed during the periods that dredging was performed from 1033 to 1747. The monitoring revealed that conditions around the dredge during operation did not vary much above the background values in the area.

Dredging proceeded at a high rate of nearly uninterrupted production during the last hour of operation on 18 August. Immediately following the cessation of dredging operations, the turbidity sensor was lowered into the moon pool just over the silt curtain. As the tide was well into flood conditions, this location was at the down-current end of the dredge. Turbidity ranged from 15 to 50 NTU in the mid- to upper-water column. Turbidity just outside of the silt curtain ranged from 16 to 63 NTU. Upper water column turbidity values were generally below 40 NTU along a transect extending approximately 150 feet down current of the dredge. Turbidity values of over 200 NTU were recorded just above the bottom (less than 1 foot (30 cm)) approximately 150 feet (46 m) down current of the dredge. The elevated turbidity may have been the result of dredging operations although elevated turbidity is typical in near-bottom waters, especially at the lower stages of the tide. Any significant “near-bottom” turbidity elevation would result re-deposition in the vicinity of the dredging area as discussed in Appendix J.

K.5.3 Analytical Results

A summary of all of the water samples (both grab and composite) collected for laboratory analysis as part of the water quality monitoring program is presented in the table shown on Figure K-21. This table includes a summary of the analytical results. The field-measured turbidity associated with each sample is presented as a range because the instantaneous turbidity readings (multiple readings each second were averaged and recorded every 2 seconds) often varied over the time required to fill the sample bottle. PCB data that did not meet the data quality objectives (DQO's) established in the QAPP (ENSR 2000) were flagged/qualified. None of the findings warranted rejection of data; selected sample or congener results were qualified with a "J" to indicate that the result did not meet project DQO's and should be considered an estimate.

Total Suspended Solids

Physical samples for the determination of total suspended solids (TSS) were collected prior to the start of dredging and during each of the four monitoring events described above in Section K.5.2. For each event the TSS concentration was measured in the composite sample representing average conditions as well as in individual grab samples. Results of the TSS analysis are presented in the table shown on Figure K-21. Results of the TSS analysis are also presented on the turbidity mapping figures for each event (Figures K-9 through K-19). In general, the TSS measurements did not display as large a degree of variability as the turbidity data. A summary of the TSS distribution is presented in Table M5-1 below.

Table K.5-1: Distribution of TSS concentrations determined from field samples.

Range of TSS concentrations determined from field samples (mg/L)					
Under 10	11 to 15	16 to 20	21 to 25	26 to 30	Over 30
10 samples	17 samples	17 samples	5 samples	3 samples	6 samples
17.2%	29.3%	29.3%	8.6%	5.2%	10.3%

The highest TSS concentrations attributed to "general dredging" were collected during the ebb tide monitoring event that was performed on 17 August; TSS observed approximately 50 feet down current of the dredge ranged up to 62 mg/L. A peak TSS concentration of 300 mg/l was measured in the sample collected in the prop-wash plume generated by the dredge support vessel *Miami-II.* A sample collected directly from the dredge moon-pool immediately following an extended period of continuous dredging had a TSS concentration of 120 mg/L. The background concentration was measured at 6 mg/L earlier in the day.

PCBs

Physical samples for the determination of PCB concentrations (dissolved and particulate) were collected prior to the start of dredging and during each of the four monitoring events described above in Section K.5.2. For each event dissolved and particulate PCB concentrations (18 NOAA congeners) were measured in the composite samples representing average conditions as well as for a limited number of individual grab samples. Summary results of total PCB concentrations (sum of the 18 individual congener concentrations) are presented below in the table shown on Figures K-21 and on the turbidity mapping figures for each event (Figures K-9 through K-19). A complete summary of the individual congener analysis can be found in the table presented on Figure K-22 for the particulate PCBs and in Figure K-23 for the dissolved PCBs. Plots of the composite sample concentrations versus distance from the dredging operation are presented on Figures K-24 and K-25.

Particulate PCBs - On 7 August, just prior to the start of dredging, total particulate PCB concentrations were measured at 0.25 ug/L approximately 1000 feet (305 m) to the south of the test area and at 0.89 ug/L in the shallower waters approximately 1000 feet (305 m) to the north of the test area. Total particulate PCB concentrations at the reference station ranged from 0.11 ug/L to 0.89 ug/L during the 16-18 August monitoring period. Down-current composite sample concentrations ranged from a low of 0.85 ug/L (16 August ebb tide at station 500 feet (152 m) down current) to a high of 2.6 ug/L (16 August flood tide at station 50 feet (15 m) down current and 17 August flood tide at station 700 feet (213 m) down current). Total Particulate PCBs were also collected as grab samples during specific events. A total particulate PCB concentration of 23.0 ug/L was measured for the grab sample collected directly from the moon pool, and a concentration of 26.0 ug/l was measured for the grab sample collected in the plume down current of the support vessel *Miami II.*

Dissolved PCBs - On 7 August, just prior to the start of dredging, total dissolved PCB concentrations were measured at 0.18 ug/L approximately 1000 feet (305 m) to the south of the test area and at 0.52 ug/L in the shallower waters approximately 1000 feet (305 m) to the north of the test area. Reference station total dissolved PCB concentrations ranged from 0.21 ug/L to 0.9 ug/L during the 16-18 August monitoring period. Down-current composite sample concentrations ranged from a low of 0.52 ug/L (16 August flood tide at station 500 feet (152 m) down current) to a high of 2.7 ug/L (17 August ebb tide at station 50 feet (15 m) down current). Grab samples were collected during specific events. A total dissolved PCB concentration of 4.6 ug/L was measured for the grab sample collected directly from the moon pool, and a concentration of 2.7 ug/L was measured for the grab sample collected in the plume down current of the support vessel *Miami II.*

The equipment blanks did contain detectable (but very low) levels of selected PCB congeners. On an 18-congener sum total basis, the particulate PCB concentrations in the blanks were lower than the "cleanest" field sample particulate PCB concentrations by more than two orders of magnitude. The dissolved PCB concentrations in the blanks were lower than the "cleanest" field sample dissolved concentration by a factor of five, and most field samples had dissolved concentrations an order of magnitude or more greater than the concentrations in the blanks. As these blank concentrations were much lower than those measured for the field samples, the teflon sampling tube/pump system and designated flushing procedures were considered to be sufficient to maintain sample integrity. Nonetheless, an action level five times higher than the equipment blank detected concentration was established, and individual congener results were qualified (U) if determined to be below this action level to account for any possible impact.

K.6 DISCUSSION

K.6.1 Dredge Performance

The water quality monitoring performed during dredging on 16-18 August provided data over a range of operational and environmental conditions. Upon examination of the data, the following conclusions can be made:

- The actual dredging process (removal of sediments with the hydraulic excavator) appeared to have a limited impact on the water column;

- Activities performed in support of the dredging (operation of support vessels) appeared to have a much greater impact on water quality than the dredging; and

- Normal fluctuations in water quality occur in the Upper Harbor related to changing environmental conditions that appear similar or greater in scale than the overall impacts related to the actual dredging process.

Water Quality Impacts Related Specifically to Dredging

The monitoring performed during the ebb tide on 16 August provides the best representation of impacts associated specifically with dredging. Dredging was performed with limited shutdown during this monitoring period, and there was limited support vessel activity. Although rainfall occurred on the morning of the 16th, the effect of the runoff was assumed similar for all the composite samples (both up and down current). Field measured turbidity showed some spikes in the vicinity of the dredge but generally returned to background levels within 500 feet (152 m) down current of the dredge. Total particulate PCB concentrations were elevated (approximately 50% greater then background) in the vicinity of the dredge, but returned to background levels within 500 feet (152 m) down current of the dredge. During the other monitoring events, some of the turbidity transects revealed little or no detectable elevation of turbidity down current of the dredge. Larger increases in turbidity were generally traceable to dredge support activities or environmental conditions as discussed below.

The limited water column impacts associated specifically with the dredging are attributed to both operational and environmental factors. The design of the bucket (tight closing with limited leakage), the configuration of the dredge (with a "moon-pool" work area enclosed behind a 36-inch (0.6 m) silt curtain), and the controlled manner in which the operation was executed all contributed to minimizing the release of material to the water column. The shallowness of the area (maximum depth of the dredged area was less than 10 feet (3 m) at high tide) and the limited currents (maximum currents generally less than 0.5 feet/sec (15 cm/sec)) limited transport away from the dredging area.

Difficulties associated with handling and transferring sediments containing debris and large components of embedded shells did cause regular suspensions of dredging operations. However, the periods of continuous dredging were sufficient enough to allow setup of "steady state" conditions in the near field area (within 200 feet (61 m) of the dredge) to be included in the monitoring. More continuous dredging over a full or multiple tidal cycles would not be expected to generate a turbidity plume of greater extent in the nearfield area down current of the dredge than that observed during the field test. Based on the modeling predictions presented in Section K.2, any additional farfield increases are expected to be limited to the Upper Harbor.

Water Quality Impacts Related to Dredging Support Activities

The photographs presented in Figure K-26 provide a good example of the potential water quality impacts of support activities relative to the dredging operation. The photos were taken approximately 1.5 to 2 hours into the ebb tide on 17 August. At the time the upper photo was taken, the dredge was not in operation, and the tug *Miami II* was returning a support barge from the dredge to the shore. Due to the pipeline/dredge configuration, the tug had to transit in shallow water to the east of the dredge (estimated at 4 to 5 feet (1.2-1.5 m) in depth at this tidal stage) and subsequently created a large turbidity plume. The water-quality monitoring vessel can be seen taking measurements within the plume in the same photograph. A water sample collected within 50 feet (15 m) of the tug after its passage had a suspended solids concentration of 300 mg/L and particulate and dissolved PCB concentrations of 26 and 2.7 ug/L, respectively (reported as the sum of the 18 NOAA congeners). In the lower photo taken approximately 30 minutes later, the dredge had resumed operations, and the tug was pushing ahead to hold the barge at the shore support area. A large turbidity plume is again visible behind the tug, being carried to the south on the ebb tide.

Although the dredge was not operating when the upper photo was taken, monitoring performed earlier during nearly continuous operations recorded a plume of much less extent than that associated with the tug. In the lower photograph the dredge was in operation. Water depths are approximately 6 feet (1.8 m) in the vicinity of the dredge (operating in cut 2).

Water Quality Fluctuations Related to Environmental Factors

The monitoring performed in support of this field test reinforced the importance of understanding the normal fluctuations in water quality that occur independent of the operation being monitored. An example of these fluctuations was captured on August 7th in the Upper Harbor reference samples collected for PCBs. The reference stations were collected prior to the start of dredging operations and were higher by a factor of three for the station 1000 feet (305 m) north of the pre-design area than for a station 1000 feet (305 m) south of the pre-design area (both particulate and dissolved PCB).

The flood-tide monitoring performed on 16 August provides a good example of normal fluctuations of turbidity within the Upper Harbor. Turbidity values at the background station increased from approximately 10 NTU at the start of monitoring to nearly 200 NTU an hour later (higher values than those recorded downstream of the dredge, see Figure K-12). This increase in turbidity was attributed to storm-water discharge to the harbor following the rainfall earlier in the day. At the end of the monitoring period, the entire monitoring area displayed an elevated turbidity of approximately 30-60 NTU (Figure K-13). The elevated turbidity values were not, however, accompanied by increased PCB concentrations at the reference station.

K.6.2 Correlation Analysis

The data revealed an excellent correlation between TSS and total particulate PCB concentrations. As shown in Figure K-27, the coefficient of fit for the linear relationship between these two parameters was 0.84. This relationship demonstrates the general uniformity of contamination within the sediments disturbed during the dredging, i.e., processes that resulted in increasing the suspended solids load to the water column resulted in a concomitant increase in the particulate-related contaminant load to the water column. The strength of this linear relationship allows TSS to serve as a good indicator of particulate PCB concentrations associated with operations of similar scope to the pre-design work.

A poor correlation was achieved for the linear relation between total dissolved PCB concentrations and both total particulate PCB concentrations and TSS, with an exponential function providing a better fit to the data (see Figures K-28 and K-29). This type of correlation is expected given that different processes can be responsible for controlling the concentration of dissolved PCB and the particulate load in the water column. A review of the individual dissolved/particulate data pairs reveals the following:

- For the reference samples (up current of the dredging operations), the dissolved and particulate PCB concentrations were generally similar (on a per liter basis), with the dissolved concentrations sometimes exceeding the particulate. This accounts for the portion of the regression line with a slope near 1 in Figure K-28, (between 0 and 1 ug/L total particulate PCBs).

- For the samples impacted by the dredging operations, the total particulate PCB concentration was generally increased to a much greater degree than the dissolved PCB concentration. This accounts for the portion of the regression with a flatter slope in Figure K-28, (>1 ug/L total particulate PCBs).

The data revealed a moderate correlation between lab-measured total suspended solids (TSS) and field-measured turbidity. As shown in Figure K-30, the coefficient of fit for the linear relationship between these two parameters was 0.56. The extreme values associated with the grab samples collected from the *Miami II* plume and the dredge moon-pool were not included in the regression as they were far outside of the range of the main body of data points. It should also be noted that although the tube-intake for the pumped sample (for TSS analysis) was located near the in-water turbidity sensor, the two data sets could differ due to small-scale variations in the water column. Measurement of both parameters from the exact same water parcel would be expected to increase the strength of the relationship. Given the strength of this relationship and the related relationship of TSS and total particulate PCB, field measurement of turbidity could be used as an indicator of mobilization and transport of particulate-bound PCB during full-scale remediation.

K.6.3 Comparison of Predictive Modeling and Field Measurements

The predicted transport of suspended solids using a dispersion coefficient of 10 m^2/s (108 ft^2/s) (presented in Section K.2) provides a reasonable match with the results of the field monitoring. The model predicted a maximum elevation of TSS over background of 13 mg/L, and an elevation of 5 mg/L extending approximately 400 feet (122 m) down current. The TSS levels measured in the samples collected during the field test displayed some elevations above background that were slightly higher and extended further downstream than the predictions. In addition, the turbidity measurements and TSS data revealed much greater variability in the distribution of elevations than the model predictions of TSS. These differences between predictions and measured values are understandable given the following:

- Dredging source term differences – The model assumed a constant, steady source of sediment introduced to the water column while actual dredging proceeds at a highly variable pace. The model also assumes release of the sediment over the entire water column of the designated source cells. The actual release of material during the dredging process can be much more focused at a particular location (both in x-y space and in depth).

- Additional source terms – The model did not include additional source terms from support activities in the area. In particular, the operation and grounding of the *Miami II* during the monitoring period are thought to have contributed to some of the elevations noted in the TSS data.

Comparison of the model predictions with the field measurements provided two additional insights that are important in planning additional modeling and monitoring efforts in the Upper Harbor:

- Three-dimensional flow field – Despite the shallowness of the Upper Harbor, the field measurements revealed distinct variations in the flow field over depth. Although a two-dimensional simulation provides a reasonable approximation for overall circulation, consideration must be given to the vertical variation in flow when addressing transport issues.

- Environmental factors – Even the moderate winds that occurred during the field test had a measurable impact on the current regime. This highlights the importance of the use of field measurements to assess model predictions and sample collection locations on a daily basis.

K.7 REFERENCES

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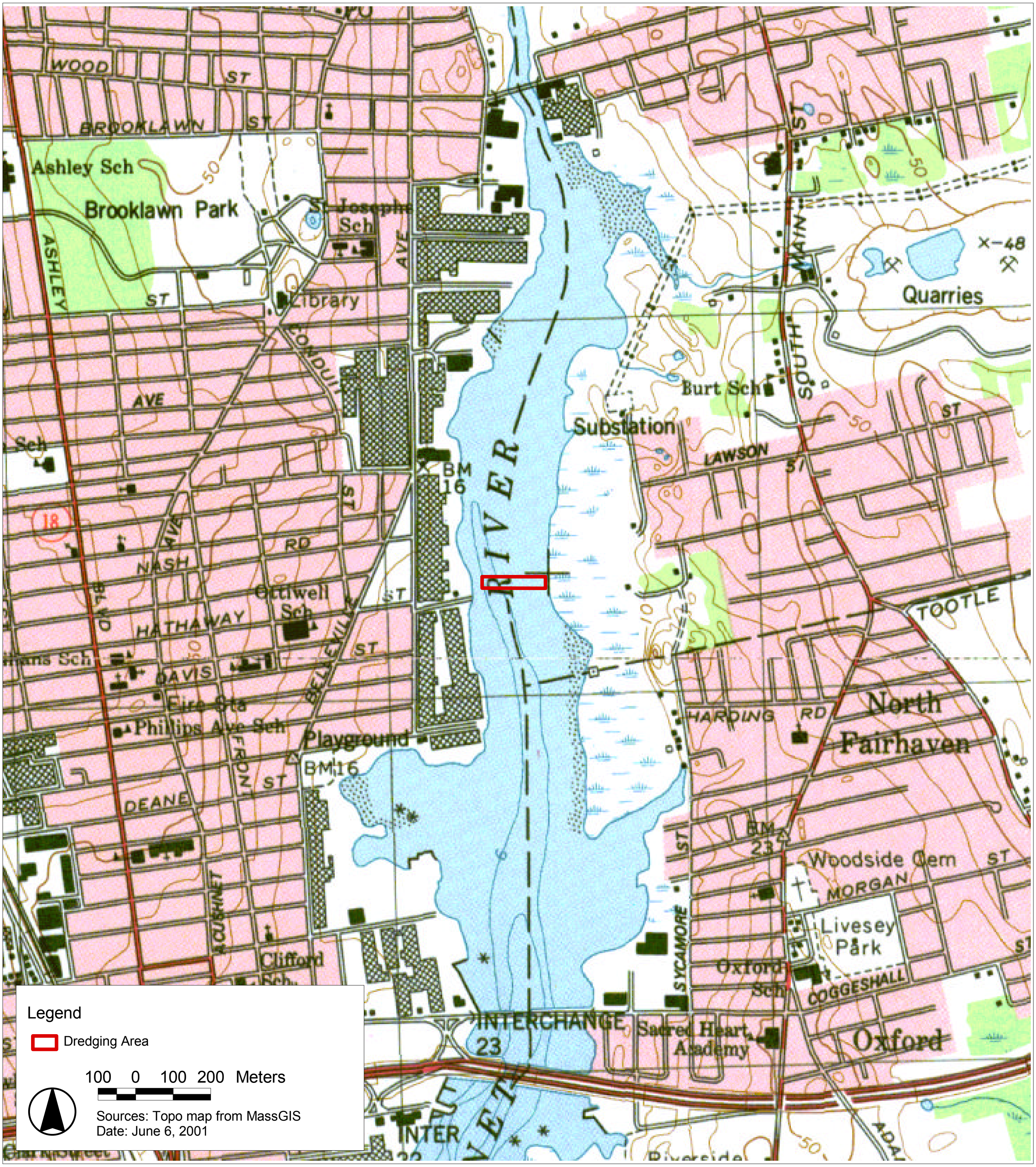
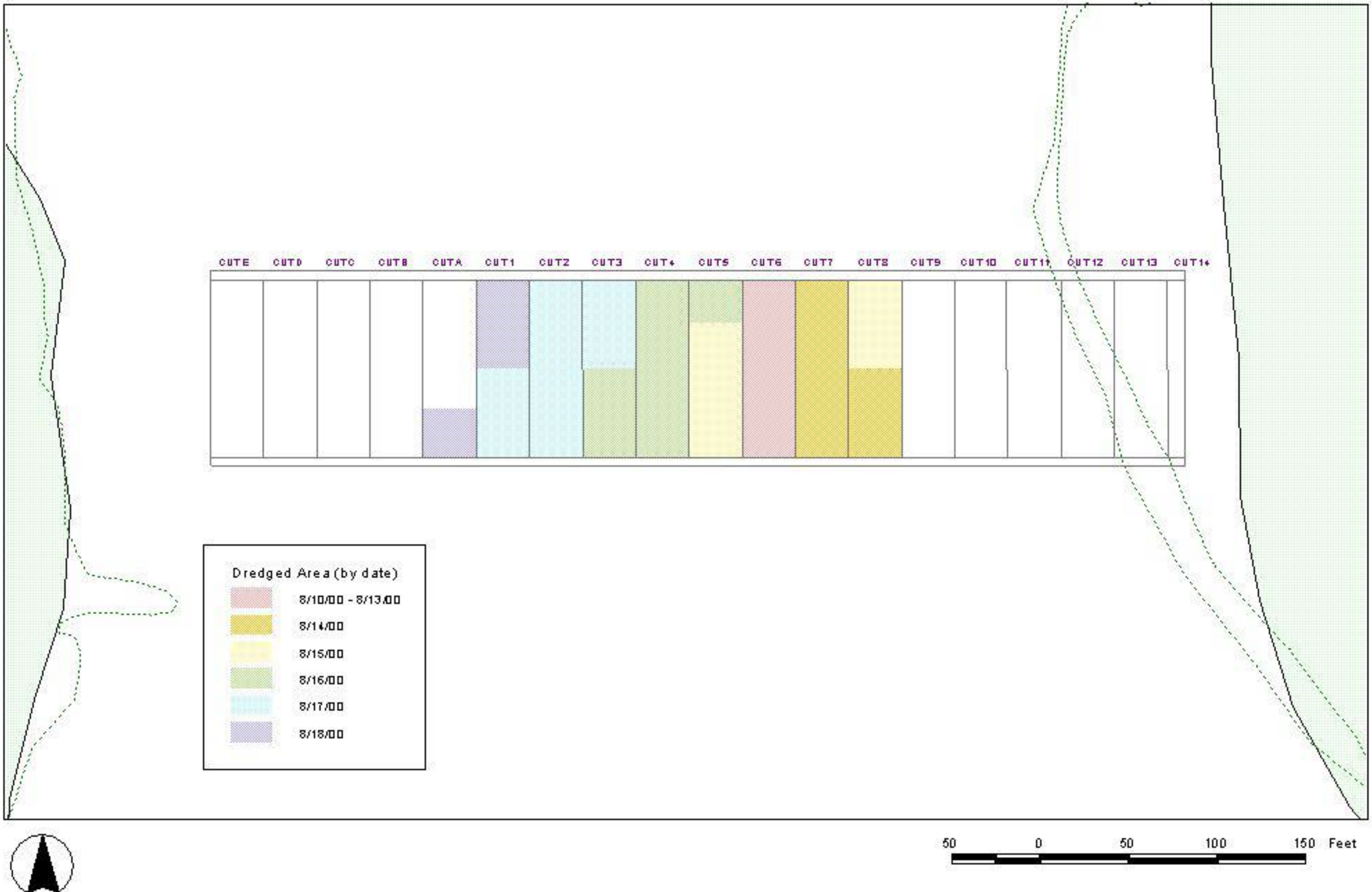


Figure K-1 Upper New Bedford Harbor Showing Pre-Design Field Test Area



March 14, 2001

Figure K-2: Pre-Design Field Test Area

U.S. Army Corps of Engineers
New Bedford Harbor Superfund Project

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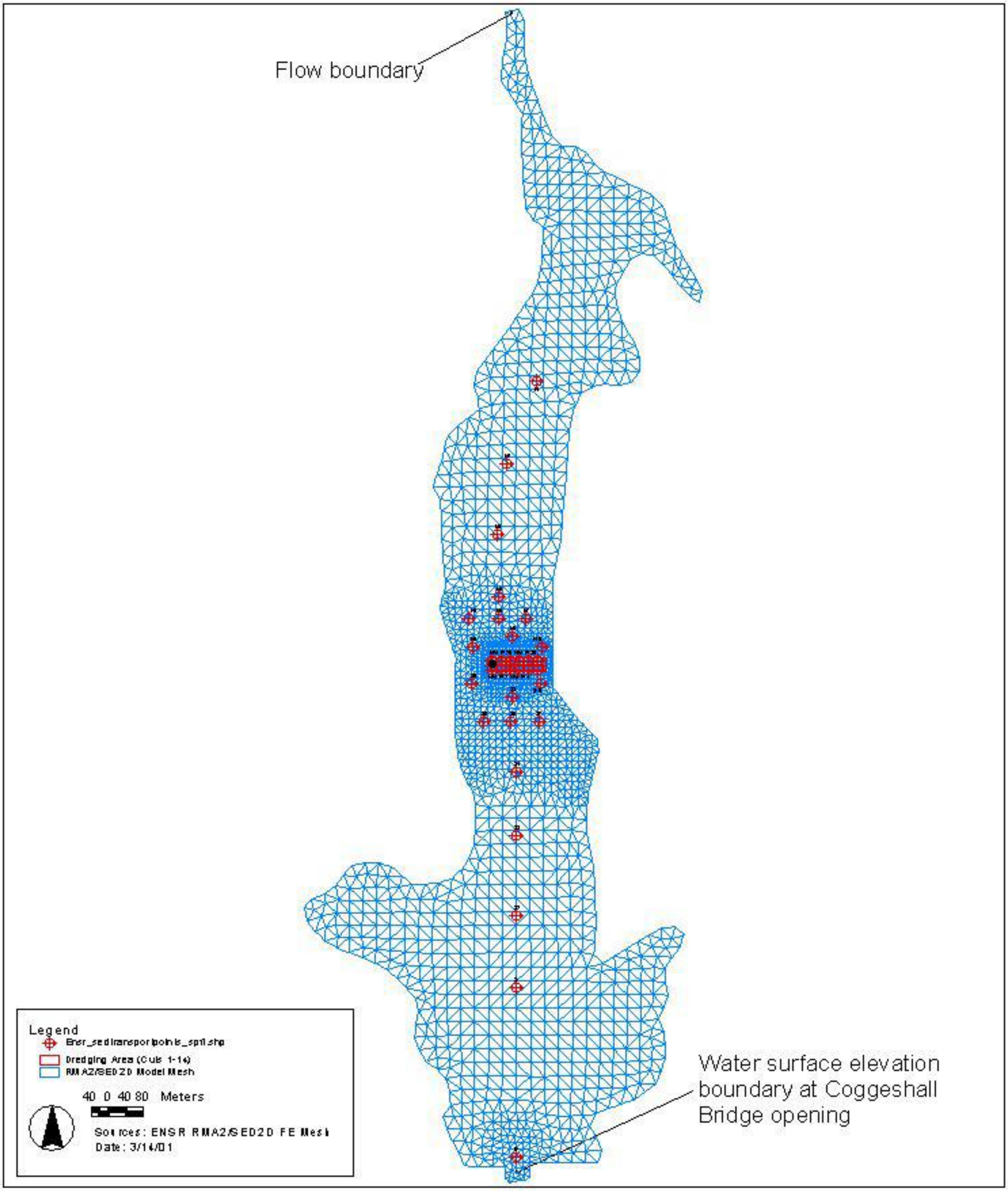
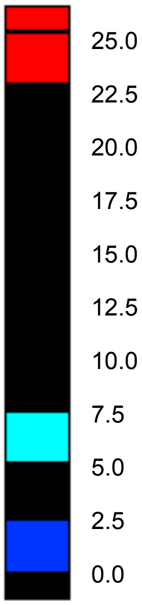


Figure K3: Upper New Bedford Harbor Numerical Model, Finite Element Mesh

Total suspended sediment concentration (mg/L)



SEDIMENT SOURCE:

- Composed of 19% sand, 53% silt, and 28% clay
- Fraction lost by dredge is 1% by mass
- Total sediment source strength of 482 kg/hr

MODEL VARIABLES:

- Dispersion coefficient of 10 m^2/s

TIDE:

- Output at Hour 20 during peak flood tide

RESULTS

- Maximum total concentration predicted during simulation is 13 mg/L above ambient

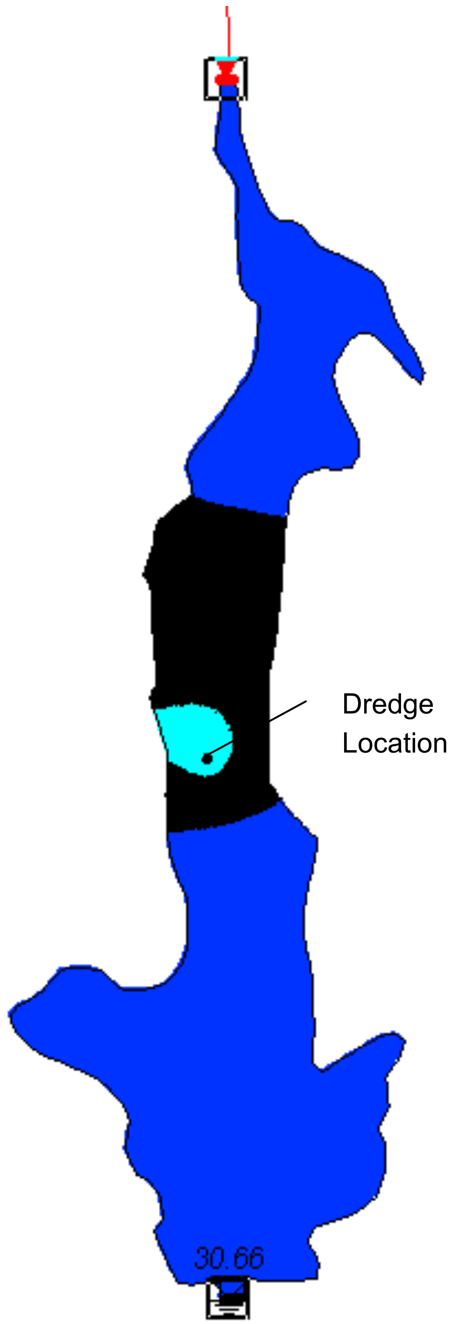


Figure K-4: Predicted Suspended Sediment Concentrations Resulting from Dredging during Peak Flood Tide.

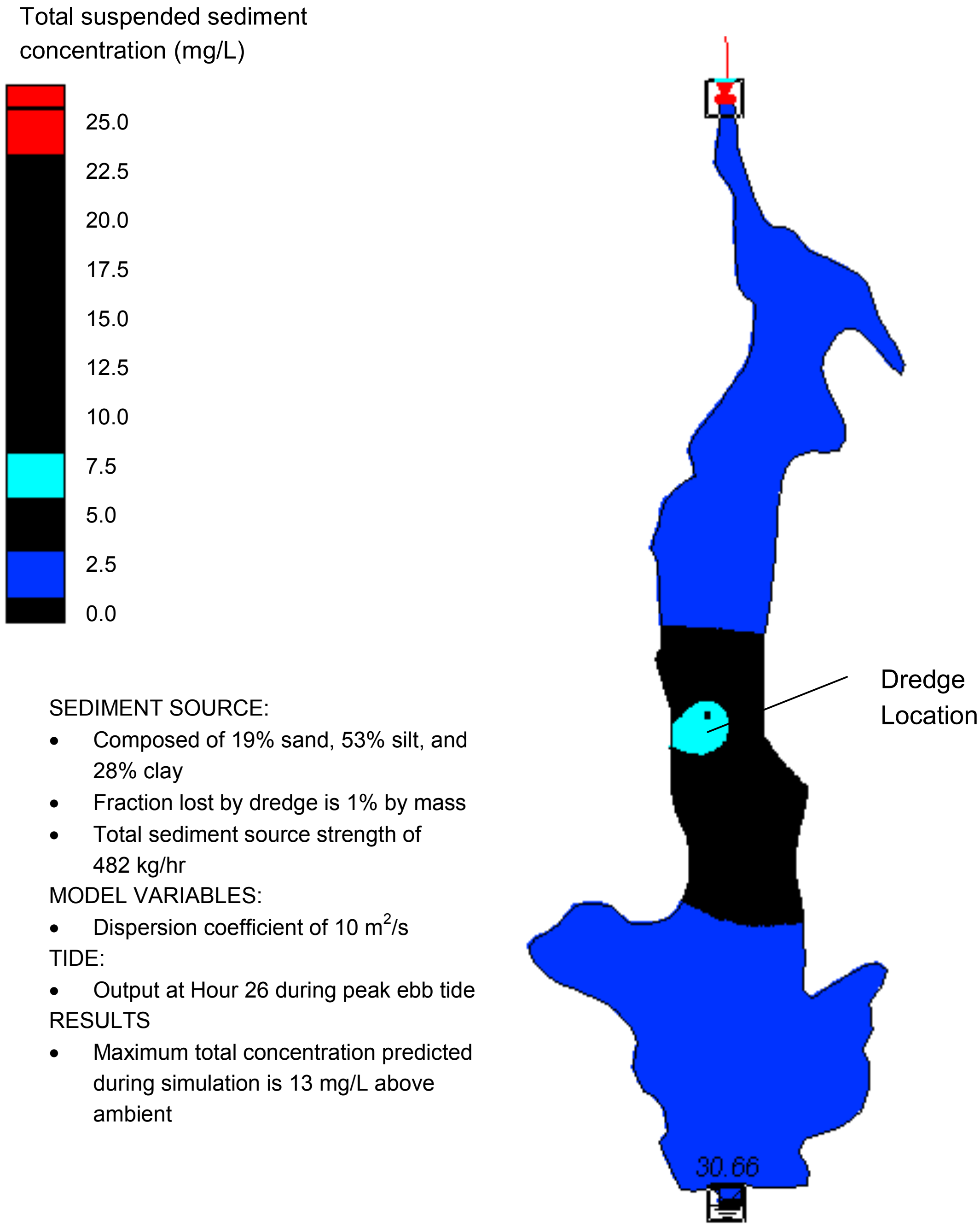


Figure K-5: Predicted Suspended Sediment Concentrations Resulting from Dredging during Peak Ebb Tide.

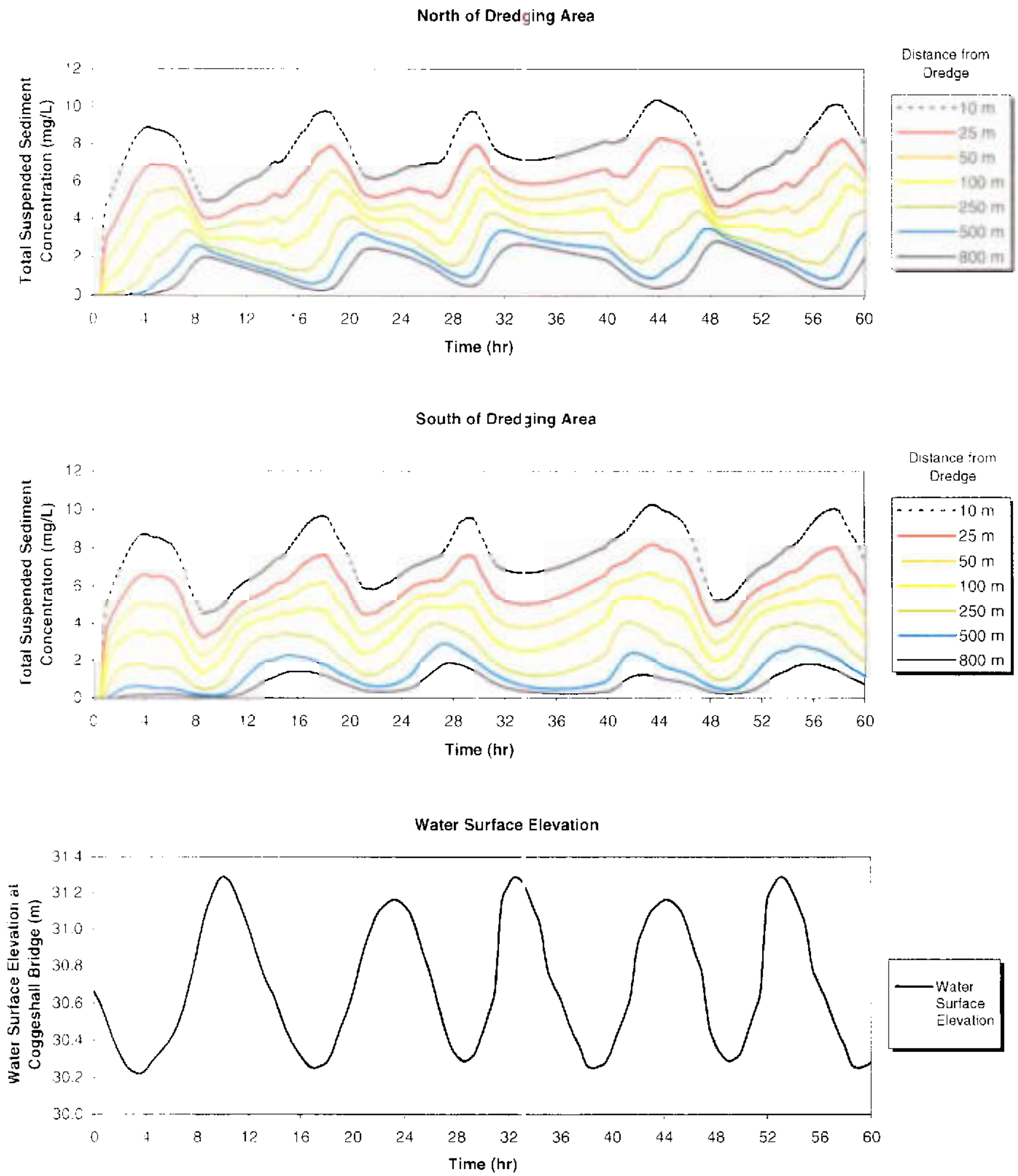


Figure K-6: Time Series of Predicted Suspended Sediment Concentrations (dredge in middle of cut 1; dispersion coefficient 10 m^2/s; source strength 482 kg/hr or 1% loss).

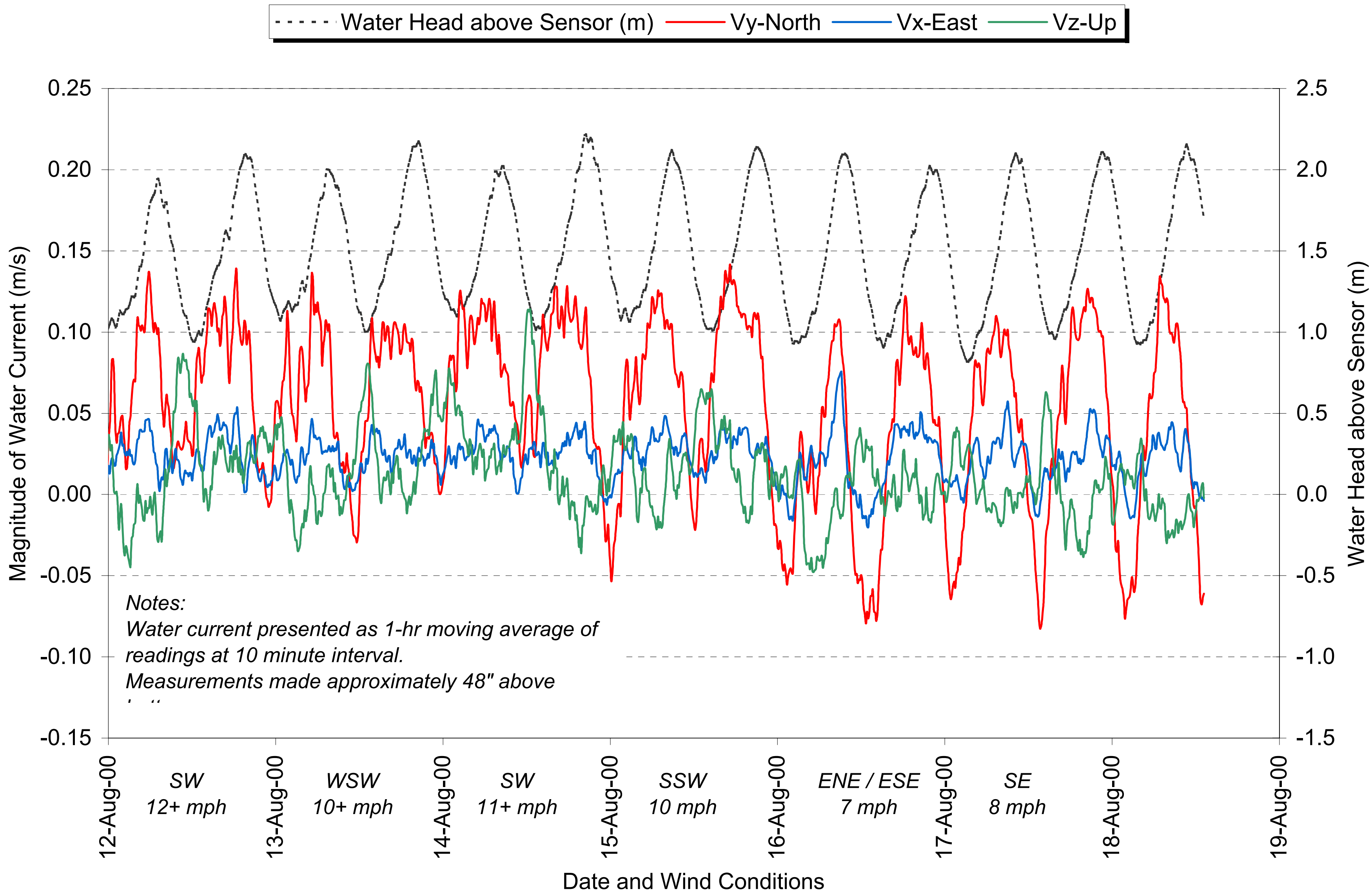


Figure K7: Aquadopp Water Current and Pressure Sensor Data

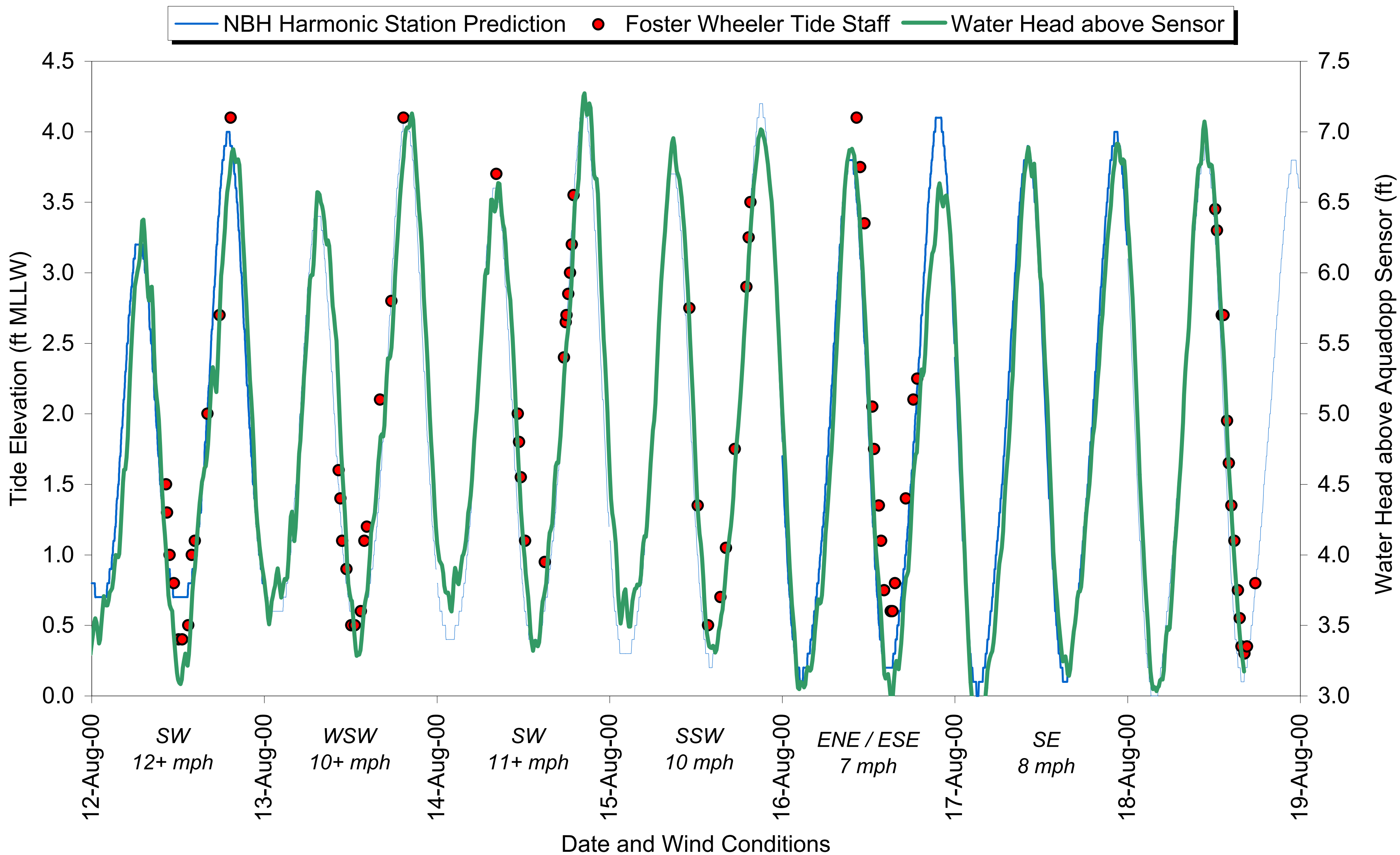


Figure K-8: Predicted/Measured Tide and Water Depth over Current Meter Sensor

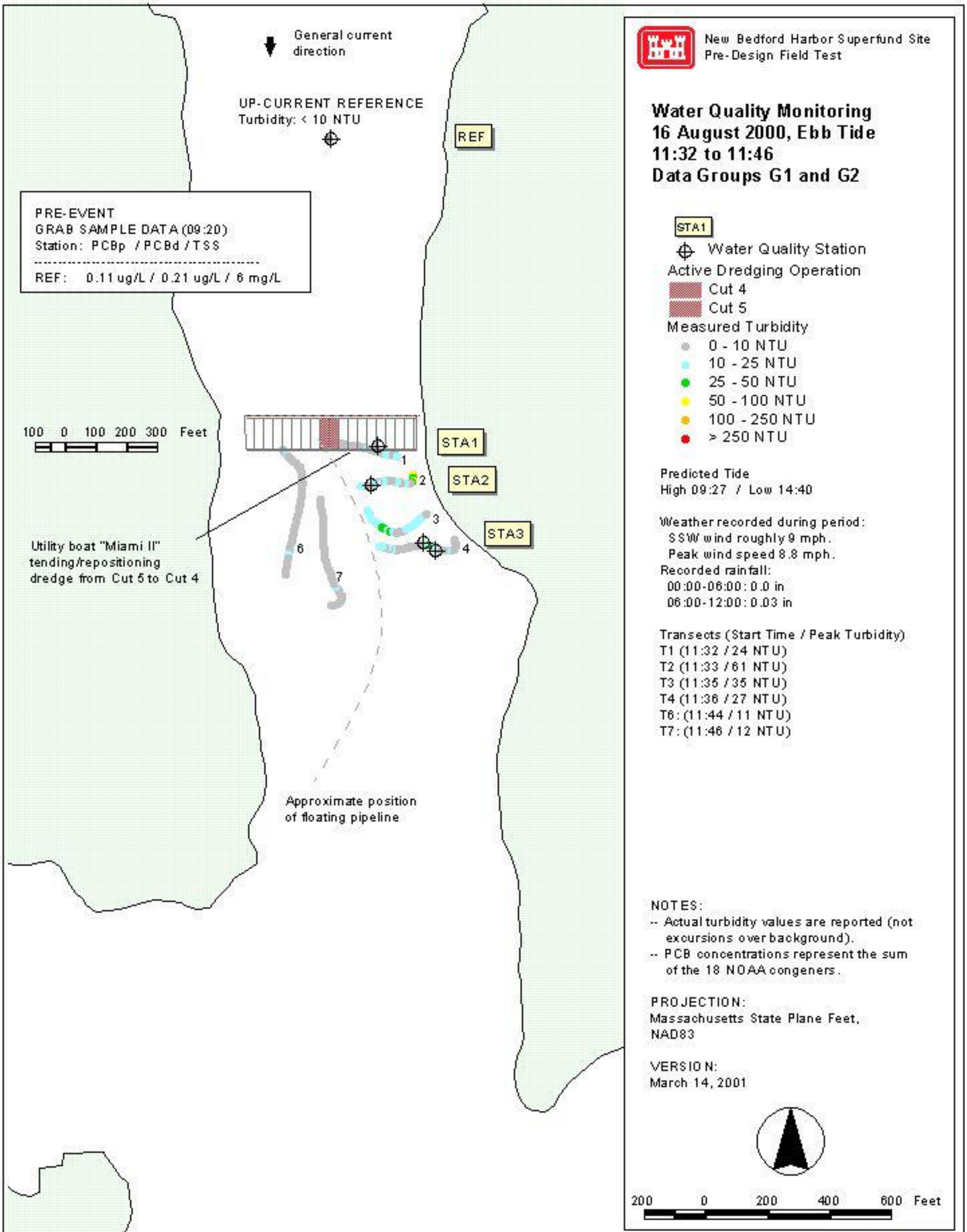


Figure K-9: Turbidity Monitoring Data, 16 August 2000, Ebb Tide, 11:32 to 11:46

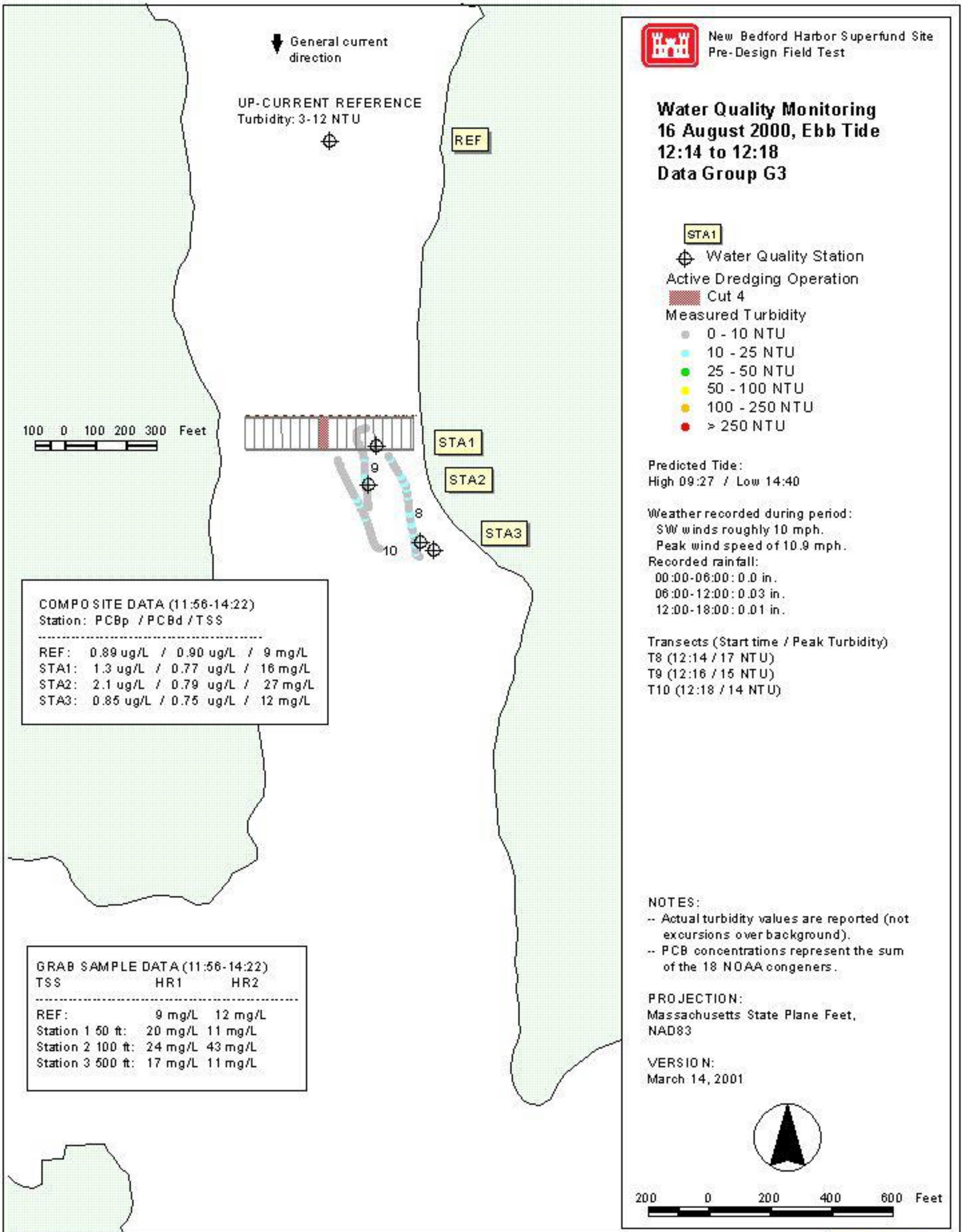


Figure K-10: Turbidity Monitoring Data, 16 August 2000, Ebb Tide, 12:14 to 12:18, Including Event Composite Sample Data

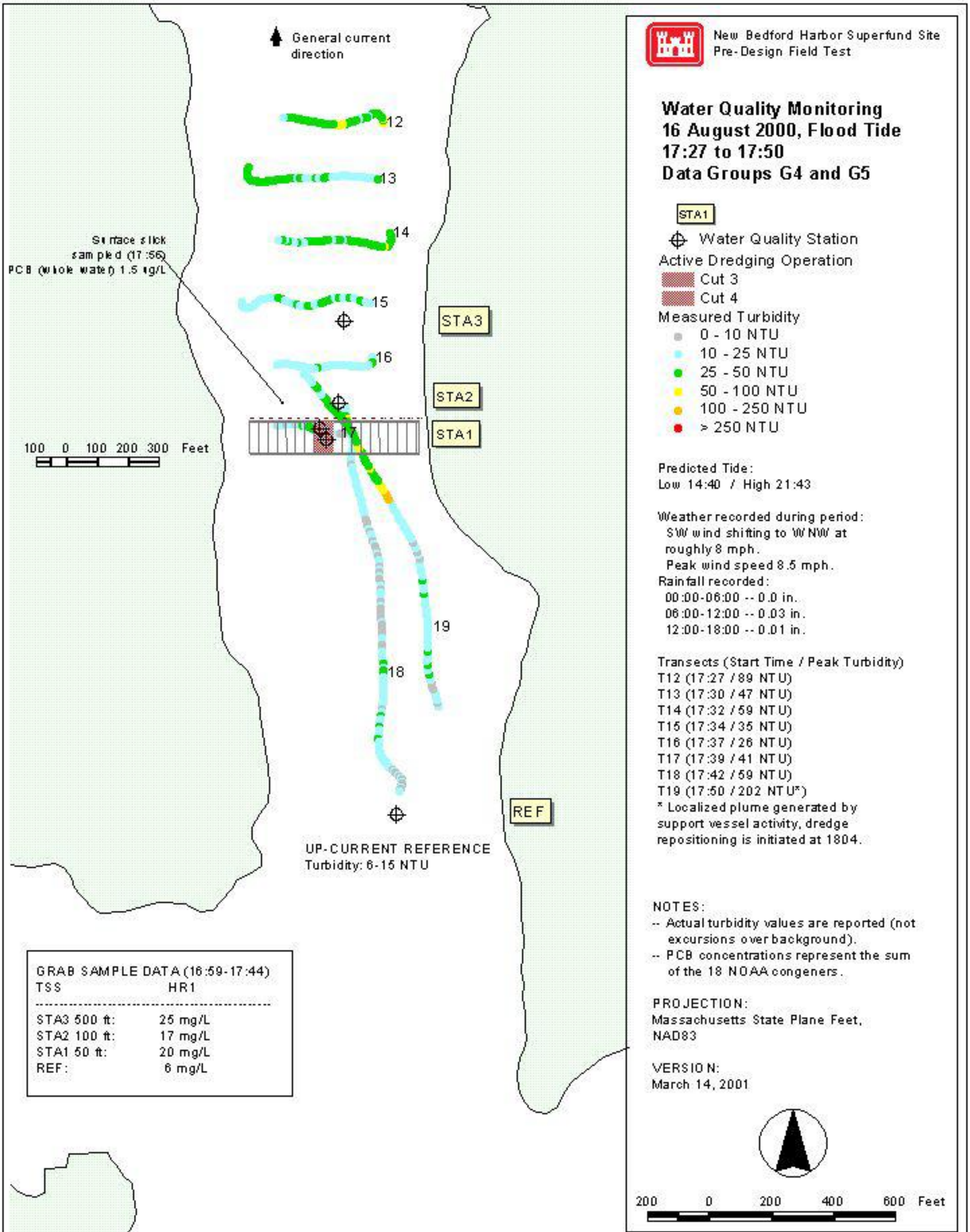


Figure K-11: Turbidity Monitoring Data, 16 August 2000, Flood Tide, 17:27 to 17:50

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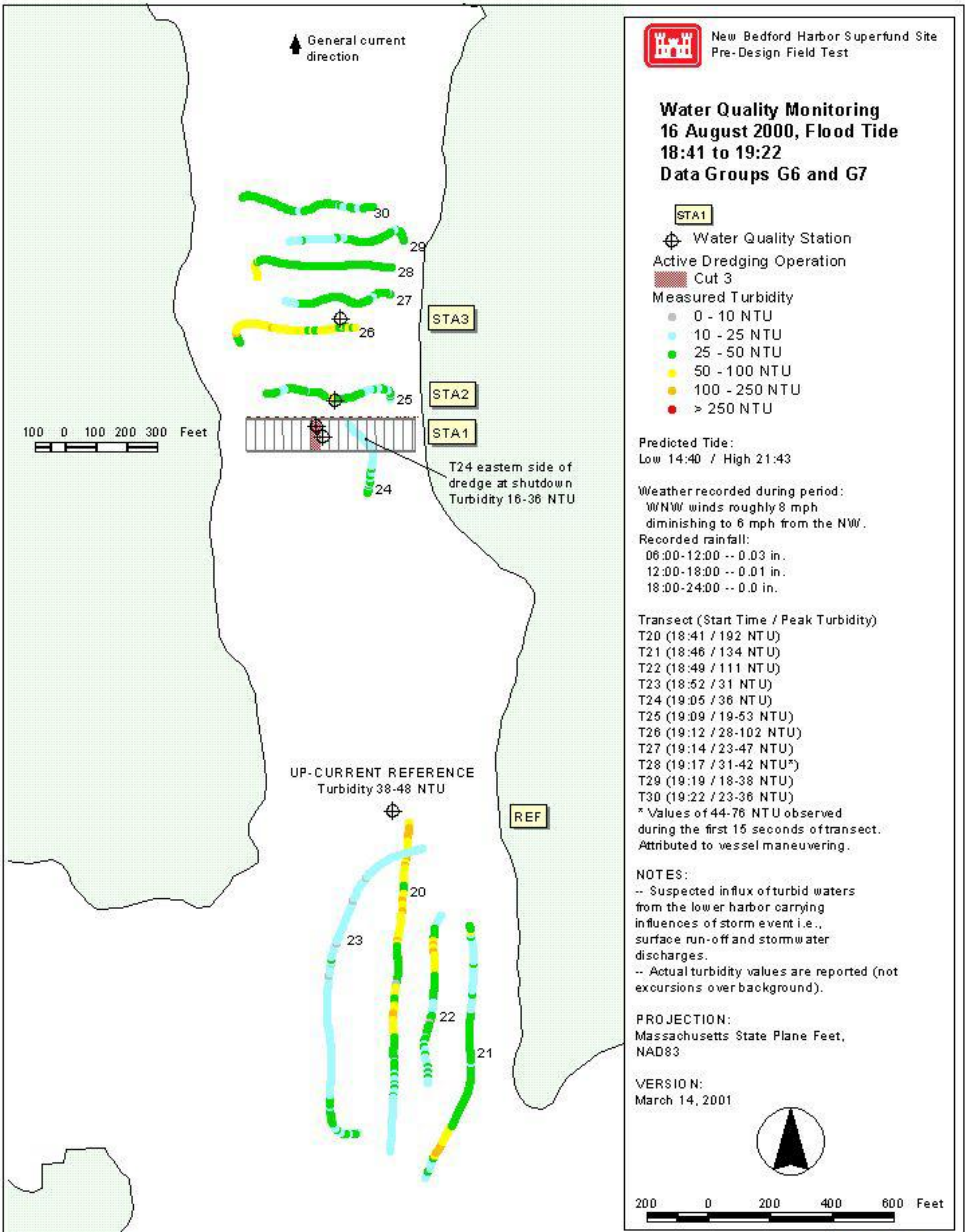

Figure K-12: Turbidity Monitoring Data, 16 August 2000, Flood Tide, 18:41 to 19:22

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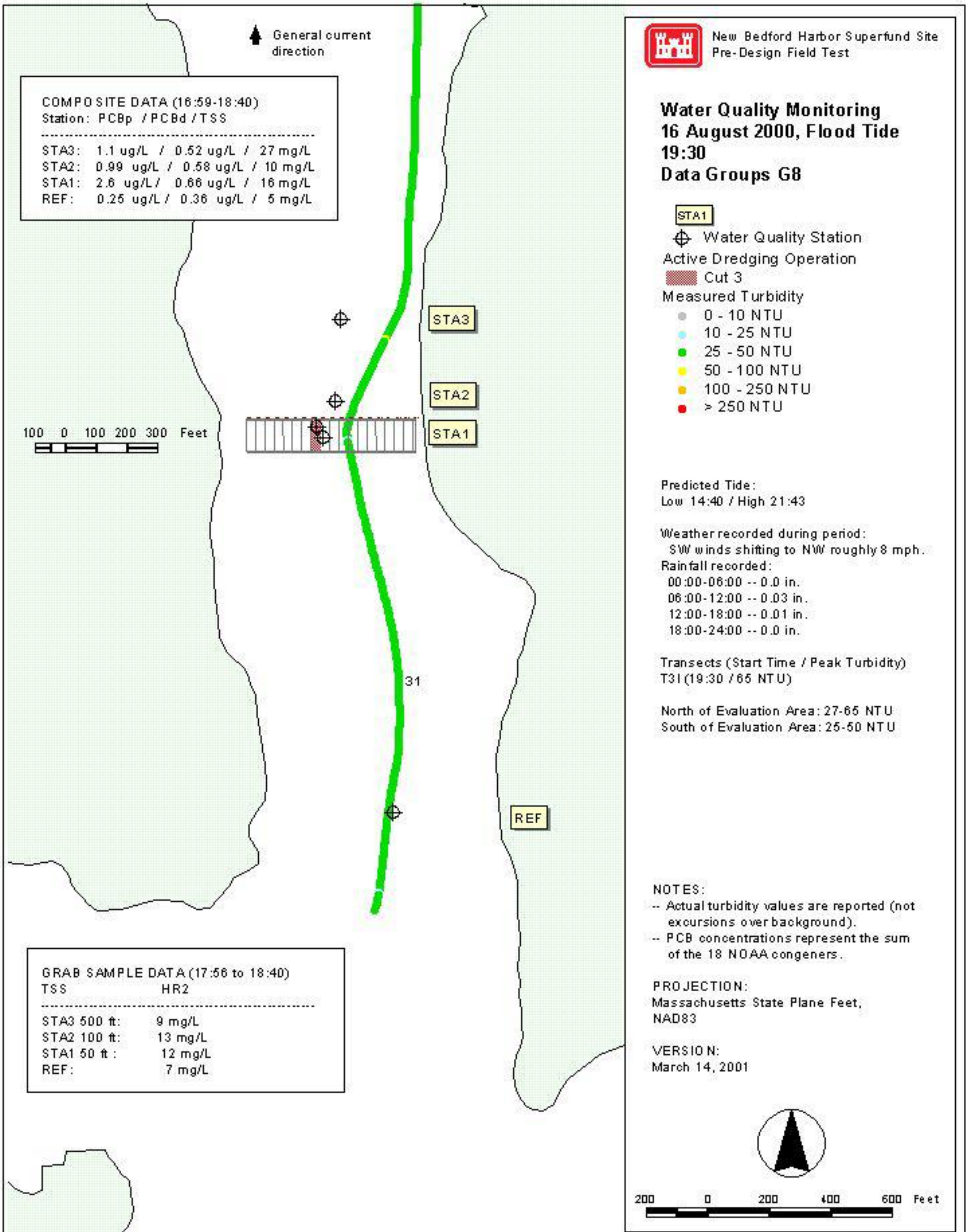

Figure K-13: Turbidity Monitoring Data, 16 August 2000, Flood Tide at 19:30, Including Event Composite Sample Data

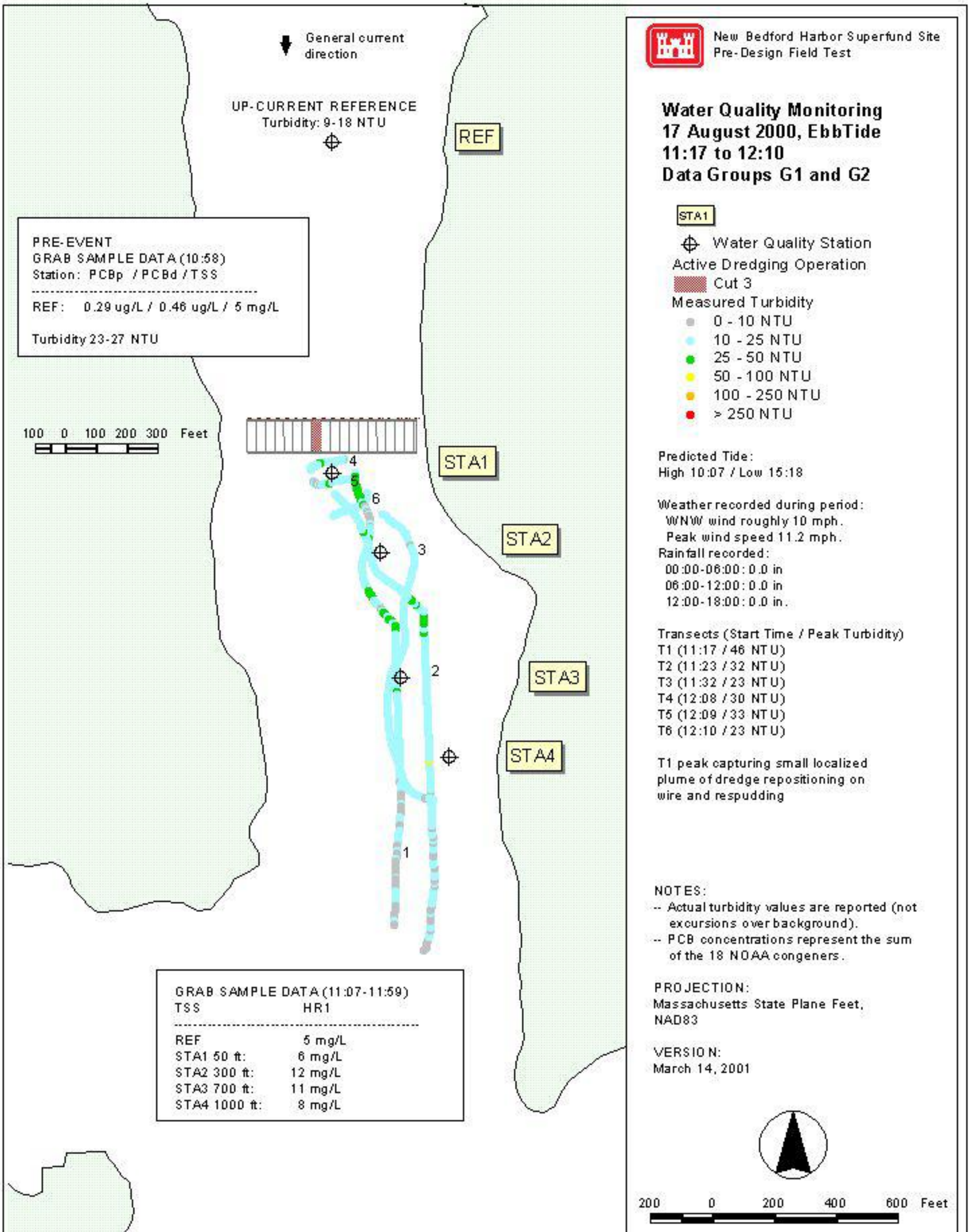

Figure K-14: Turbidity Monitoring Data, 16 August 2000, EbbTide 11:17 to 12:10

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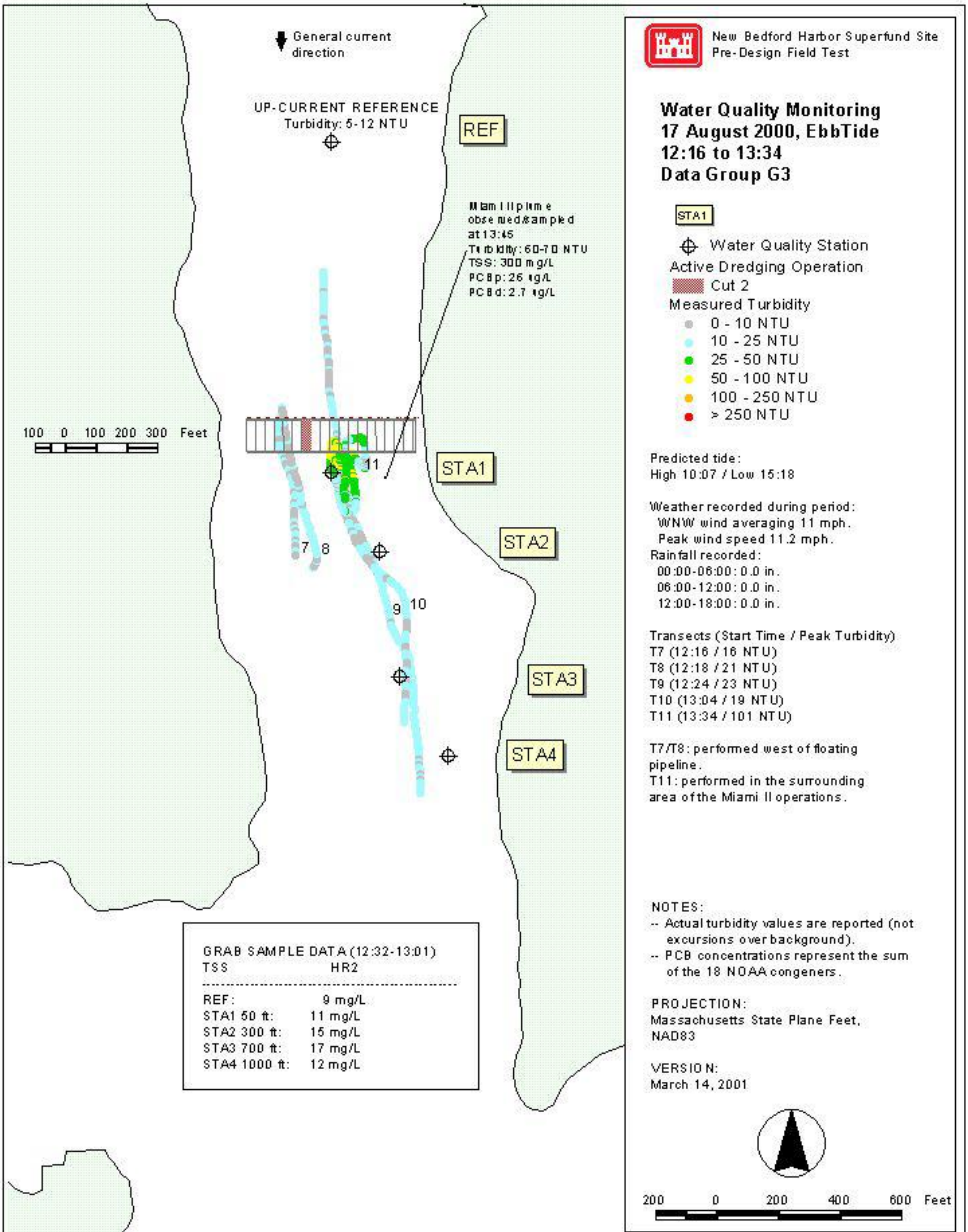

Figure K-15: Turbidity Monitoring Data, 17 August 2000, Ebb Tide 12:16-13:34

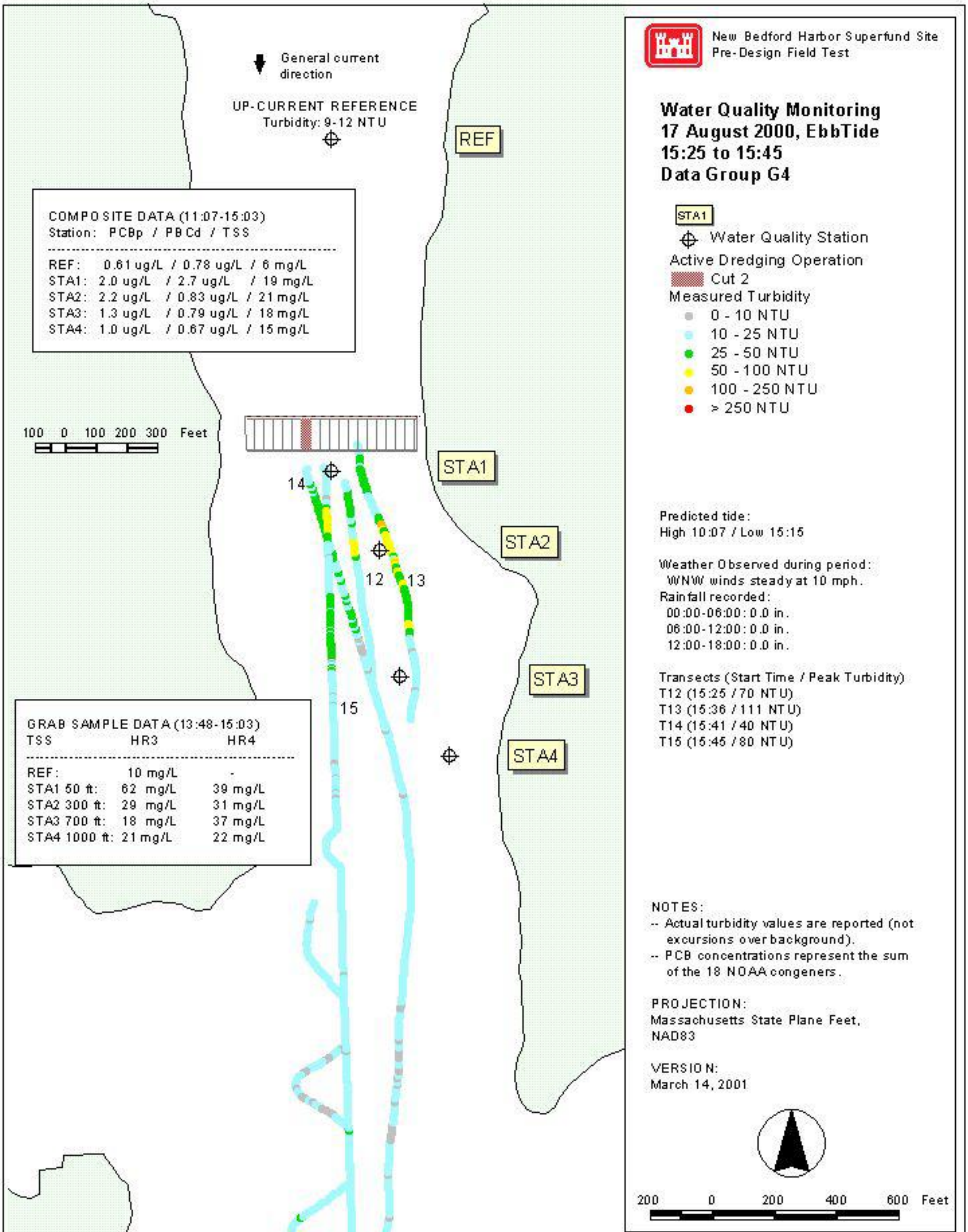

Figure K-16: Turbidity Monitoring Data, 17 August 2000, Ebb Tide 15:25 to 15:45, Including Event Composite Sample Data

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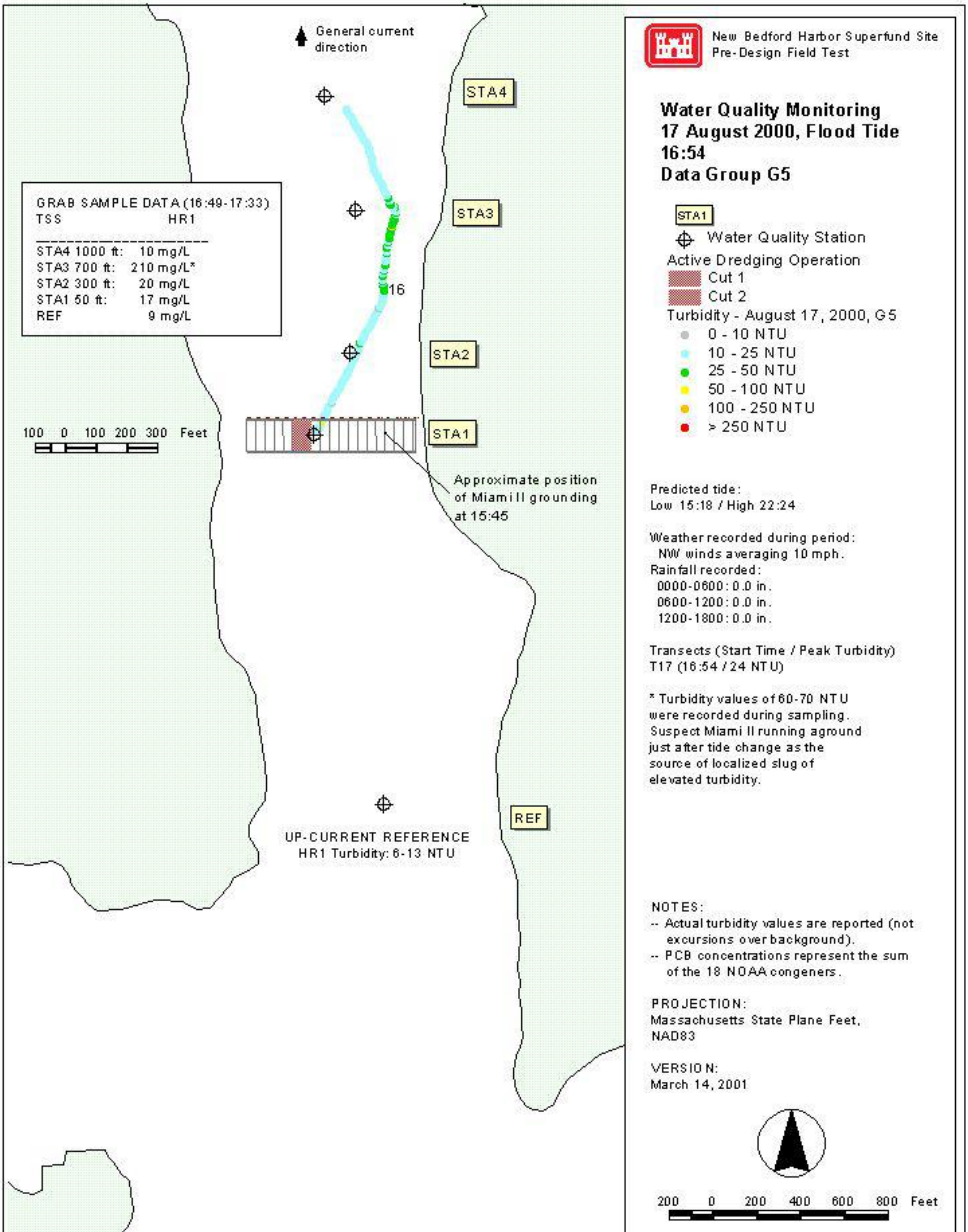


Figure K-17: Turbidity Monitoring Data, 17 August 2000, Flood Tide at 16:54

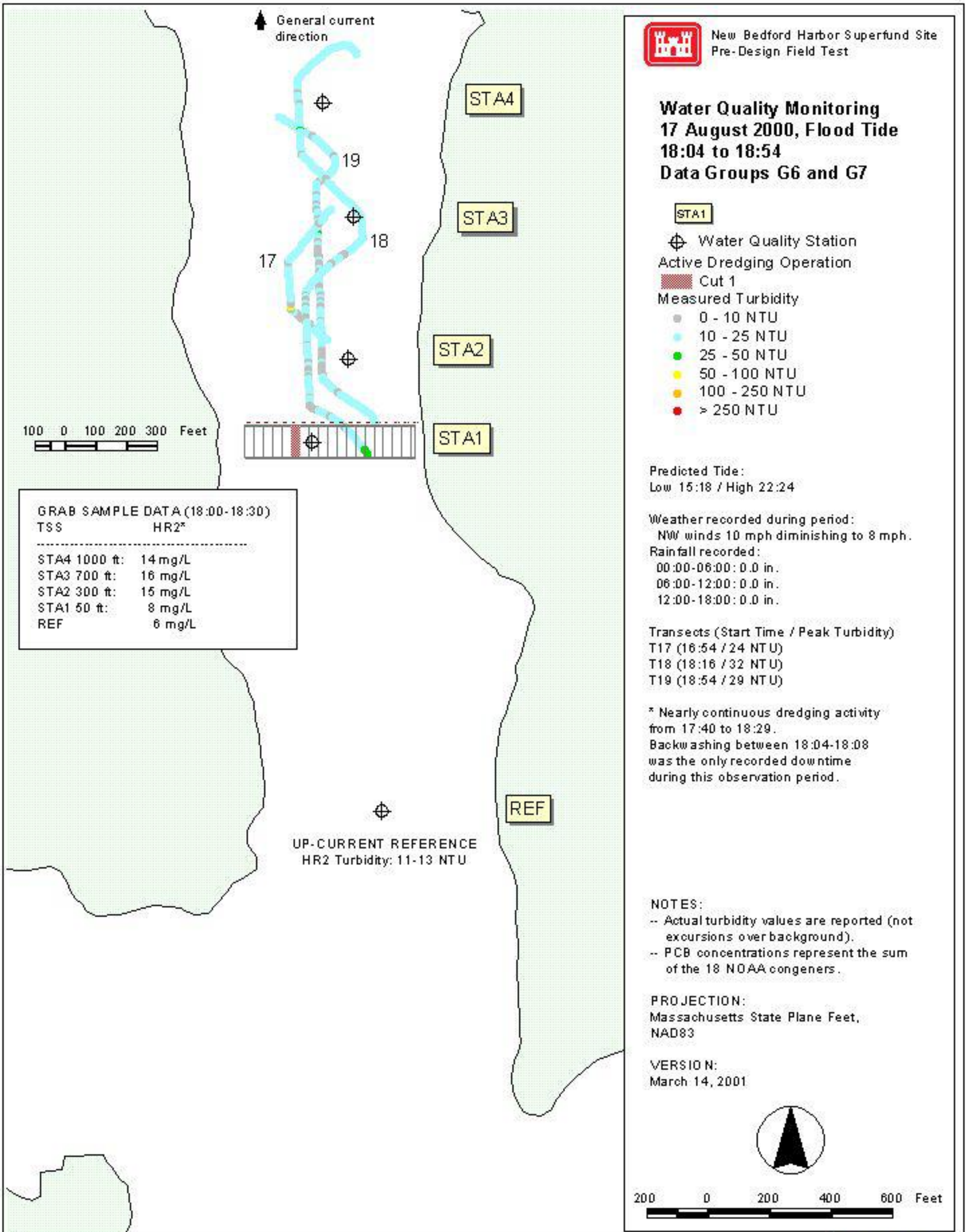


Figure K-18: Turbidity Monitoring Data, 17 August 2000, Flood Tide, 18:04 to 18:54

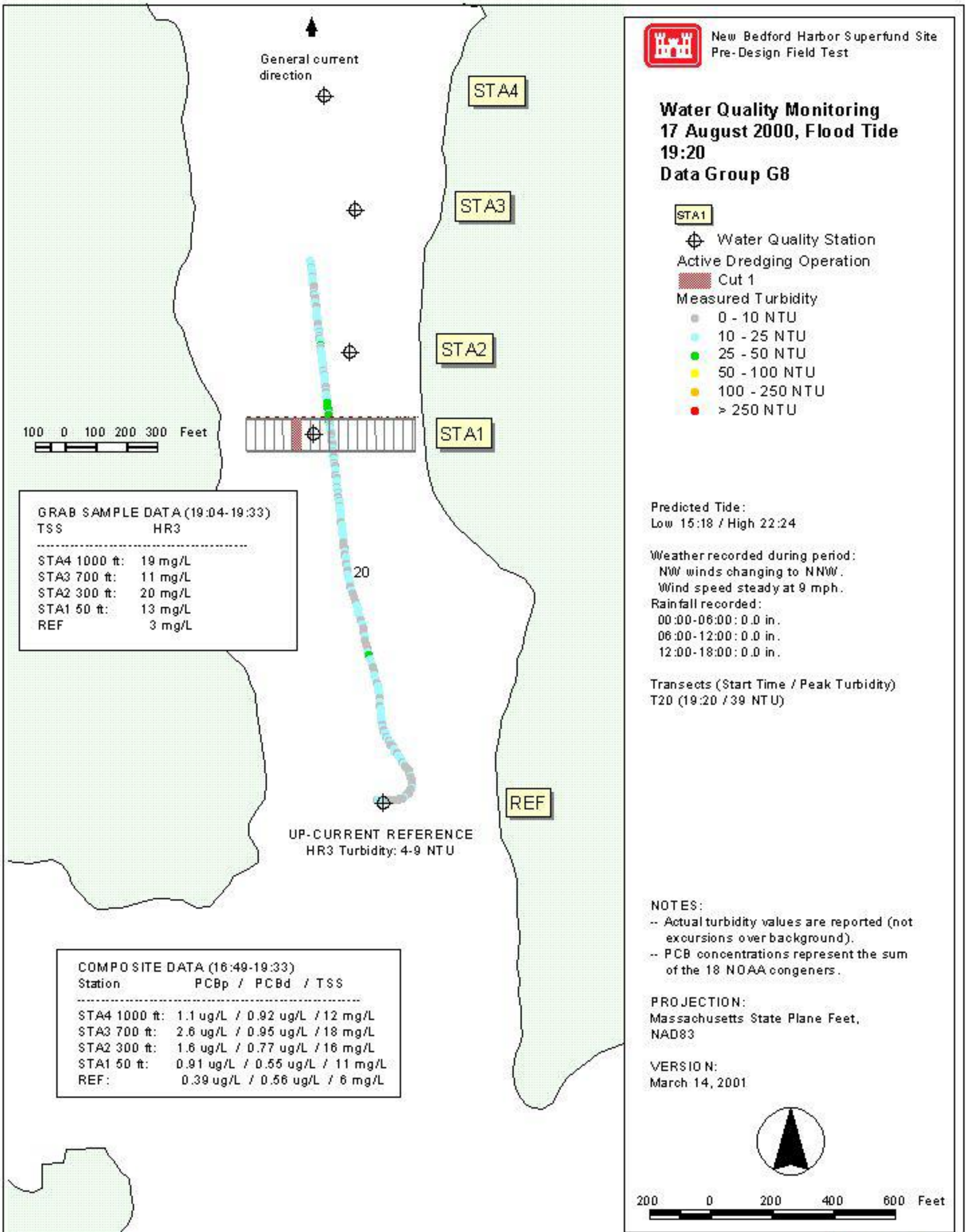


Figure K-19: Turbidity Monitoring Data, 17 August 2000, Flood Tide at 19:20, Including Event Composite Sample Data

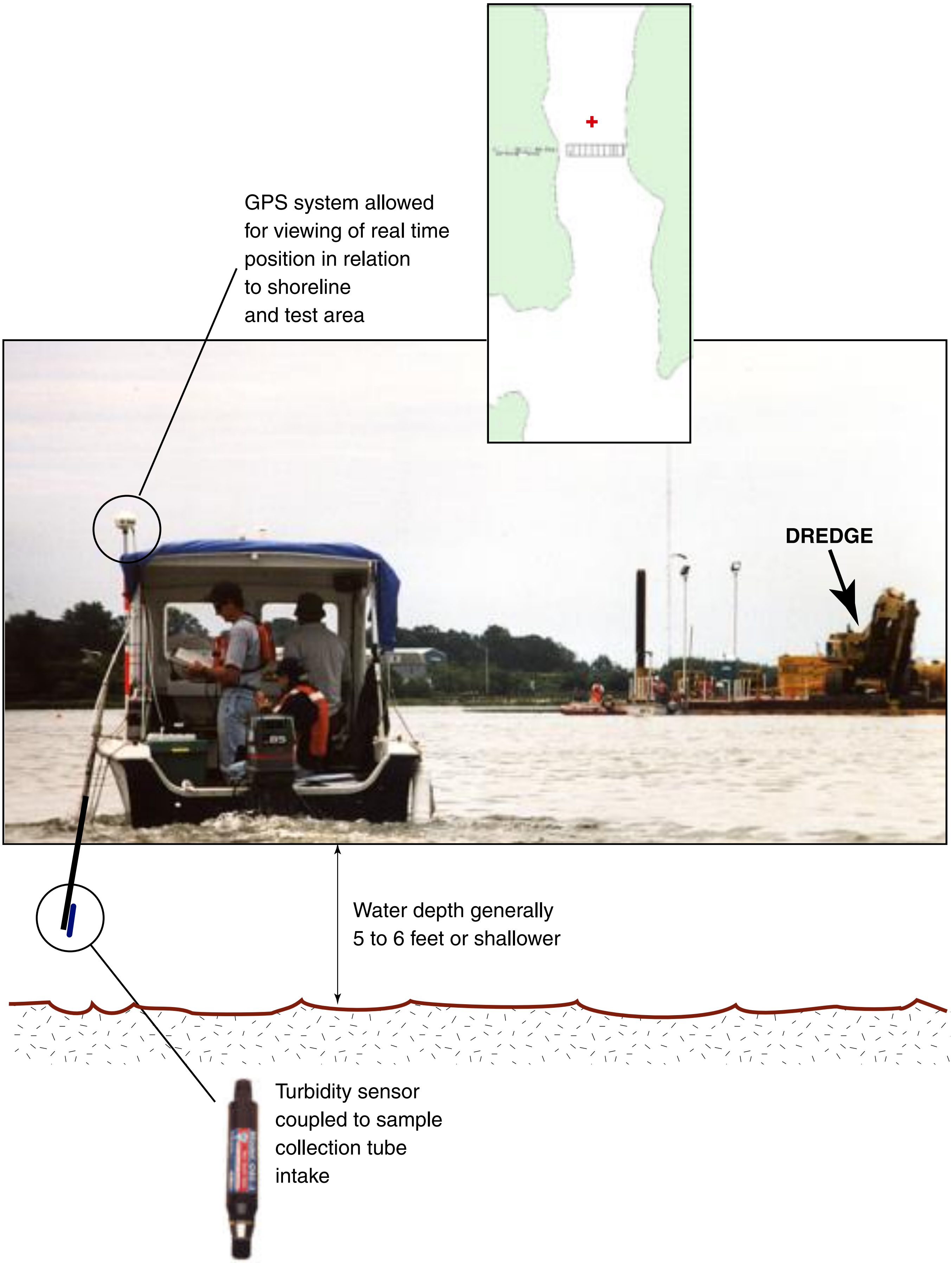


FIGURE K-20
Setup for Turbidity Monitoring

FIGURE K21
Summary of Field Samples and Analytical Data

				POSITION			Turbidity Range (NTU)				Total PCB (ug/L)		
Field Sample ID	**Date and Time Collected**			**Northing**	**Easting**	**Brief**	**MIN**	**MAX**	**AVG**	**TSS (mg/L)**	**particulate**	**dissolved**	**particulate + dissolved**
NBPDWQ1000N	07-Aug-00	16:26	Grab	2704955	815354	Background Value - Acushnet Estuary 1000ft N				10	0.89	0.52	1.41
NBPDWQ1000S	07-Aug-00	16:36	Grab	2703124	815820	Background Value - Acushnet Estuary 1000ft S				4	0.25	0.18	0.43
NBH815-1752	15-Aug-00	17:52	Grab	2704040	815356	Turbidity / TSS - Acushnet Estuary	26.0	26.0	26.0	53			
NBH0815-1805	15-Aug-00	18:05	Grab			Turbidity / TSS - Acushnet Estuary	12.0	12.0	12.0	22			
NBH815-1807	15-Aug-00	18:08	Grab			Turbidity / TSS - Acushnet Estuary	3.0	5.0	4.0	5.0			
NBH0816-R1 TSS/PCB	16-Aug-00	9:20	Grab	2703129	815608	Up-current reference sample	3.0	6.0	4.5	6.0	0.11	0.21	0.32
NBPDWQ E1-STA1-HR1	16-Aug-00	11:56	EBB			Sampling HR1 - Station 1 (50ft)	7.0	10.0	8.5	20			
NBPDWQ E1-STA2-HR1	16-Aug-00	12:02	EBB	2703959	815530	Sampling HR1 - Station 2 (100ft)	16.0	21.0	18.5	24			
NBPDWQ E1-STA3-HR1	16-Aug-00	12:11	EBB	2703621	815717	Sampling HR1 - Station 3 (500ft)	5.0	12.0	8.5	17			
NBPDWQ E1-STA4-HR1	16-Aug-00	12:22	EBB	2704948	815379	Sampling HR1 - REF (1000ft-up-current)	3.0	12.0	7.5	9.0			
NBPDWQ E1-STA1-HR2	16-Aug-00	13:16	EBB			Sampling HR2 - Station 1 (50ft)				11			
NBPDWQ E1-STA2-HR2	16-Aug-00	14:06	EBB	2703833	815506	Sampling HR2 - Station 2 (100ft)				43			
NBPDWQ E1-STA3-HR2	16-Aug-00	14:15	EBB	2703647	815675	Sampling HR2 - Station 3 (500ft)				11			
NBPDWQ E1-STA4-HR2	16-Aug-00	14:22	EBB	2704948	815379	Sampling HR2 - REF (1000ft-up-current)				12			
NBPDWQ E1 STA01	16-Aug-00		COMPOSITE			Composite - Station 1				16	1.30	0.77	2.07
NBPDWQ E1 STA02	16-Aug-00		COMPOSITE			Composite - Station 2				27	2.10	0.79	2.89
NBPDWQ E1 STA03	16-Aug-00		COMPOSITE			Composite - Station 3	23.0	27.0	25.0	12	0.85	0.75	1.60
NBPDWQ E1 STA04	16-Aug-00		COMPOSITE			Composite - REF	10.0	17.0	13.5	9.0	0.89	0.90	1.79
NBPDWQ F1-STA1-HR1	16-Aug-00	16:59	FLOOD	2703995	815351	Sampling HR1 - Station 1 (50ft)				20			
NBPDWQ F1-STA2-HR1	16-Aug-00	17:17	FLOOD	2704110	815393	Sampling HR1 - Station 2 (100ft)	20.0	20.0	20.0	17			
NBPDWQ F1-STA3-HR1	16-Aug-00	17:23	FLOOD	2704375	815410	Sampling HR1 - Station 3 (500ft)	40.0	40.0	40.0	25			
NBPDWQ F1-STA4-HR1	16-Aug-00	17:44	FLOOD	2702780	815578	Sampling HR1 - REF (1000ft-up-current)	6.0	15.0	10.5	6.0			
NBPDWQ F1-STA1-HR2	16-Aug-00	17:56	FLOOD	2704028	815329	Sampling HR2 - Station 1 (50ft)	21.0	27.0	24.0	12			
NBHPDWQ-SLICK-2	16-Aug-00	17:56	Grab			Surface oil slick observed at HR1 - Station 1 (50ft)						1.50	1.50
NBPDWQ F1-STA2-HR2	16-Aug-00	17:58	FLOOD	2704140	815363	Sampling HR2 - Station 2 (100ft)	10.0	15.0	12.5	13			
NBPDWQ F1-STA3-HR2	16-Aug-00	18:19	FLOOD	2704375	815410	Sampling HR2 - Station 3 (500ft)	39.0	42.0	40.5	9.0			
NBPDWQ F1-STA4-HR2	16-Aug-00	18:40	FLOOD	2702780	815578	Sampling HR2 - REF (1000ft-up-current)	38.0	42.0	40.0	7.0			
NBPDWQ F1 STA01	16-Aug-00		COMPOSITE			Composite - Station 1				27	2.60	0.66	3.26
NBPDWQ F1 STA02	16-Aug-00		COMPOSITE			Composite - Station 2				10	0.99	0.58	1.57
NBPDWQ F1 STA03	16-Aug-00		COMPOSITE			Composite - Station 3				16	1.10	0.52	1.62
NBPDWQ F1 STA04	16-Aug-00		COMPOSITE			Composite - REF				5.0	0.25	0.36	0.61
													0.00
NBH817-R1 TSS	17-Aug-00	10:58	EBB			Sampling - Up-current reference	23.0	27.0	25.0	5	0.29	0.46	0.75
NBPDWQ E2 STA1 HR1	17-Aug-00	11:07	EBB	2703878	815379	Sampling HR1 - Station1 (50ft)	11.0	18.0	14.5	6			
NBPDWQ E2 STA4 HR1	17-Aug-00	11:42	EBB	2702964	815758	Sampling HR1 - Station 4 (1000ft)	10.0	17.0	13.5	12			
NBPDWQ E2 STA3 HR1	17-Aug-00	11:46	EBB	2703218	815599	Sampling HR1 - Station 3 (700ft)	10.0	17.0	13.5	17			
NBPDWQ E2 STA2 HR1	17-Aug-00	11:50	EBB	2703625	815534	Sampling HR1 - Station 2 (300ft)	11.0	18.0	14.5	12			
NBPDWQ E2 STA5 HR1	17-Aug-00	11:59	EBB	2704948	815379	Sampling HR1 - REF (1000ft-up-current)	9.0	18.0	13.5	9			
NBPDWQ E2 STA4 HR2	17-Aug-00	12:32	EBB	2702964	815758	Sampling HR2 - Station 4 (1000ft)	6.0	10.0	8.0	8			
NBPDWQ E2 STA3 HR2	17-Aug-00	12:38	EBB	2703218	815599	Sampling HR2 - Station 3 (700ft)	12.0	17.0	14.5	11			
NBPDWQ E2 STA2 HR2	17-Aug-00	12:45	EBB	2703625	815534	Sampling HR2 - Station 2 (300ft)	11.0	17.0	14.0	15			
NBPDWQ E2 STA1 HR2	17-Aug-00	12:52	EBB	2703878	815379	Sampling HR2 - Station1 (50ft)	9.0	15.0	12.0	11			
NBPDWQ E2 STA5 HR2	17-Aug-00	13:01	EBB	2704948	815379	Sampling HR2 - REF (1000ft-up-current)	5.0	12.0	8.5	7			
NBH0817-1345 TSS	17-Aug-00	13:45	Grab			MIAMI II Plume (peak field turbidity)	60.0	70.0	65.0	300	26.00	2.70	28.70
NBPDWQ E2 STA1 HR3	17-Aug-00	13:48	EBB	2703878	815379	Sampling HR3 - Station1 (50ft)	28.0	34.0	31.0	62			
NBPDWQ E2 STA2 HR3	17-Aug-00	13:58	EBB	2703625	815534	Sampling HR3 - Station 2 (300ft)	19.0	23.0	21.0	29			
NBPDWQ E2 STA3 HR3	17-Aug-00	14:03	EBB	2703218	815599	Sampling HR3 - Station 3 (700ft)	13.0	18.0	15.5	18			

FIGURE K21

Summary of Field Samples and Analytical Data

				POSITION			Turbidity Range (NTU)				Total PCB (ug/L)		
Field Sample ID	**Date and Time Collected**			**Northing**	**Easting**	**Brief**	**MIN**	**MAX**	**AVG**	**TSS (mg/L)**	**particulate**	**dissolved**	**particulate + dissolved**
NBPDWQ E2 STA4 HR3	17-Aug-00	14:08	EBB	2702964	815758	Sampling HR3 - Station 4 (1000ft)	13.0	21.0	17.0	21			
NBPDWQ E2 STA5 HR3	17-Aug-00	14:38	EBB	2704948	815379	Sampling HR3 - REF (1000ft-up-current)	9.0	12.0	10.5	10			
NBPDWQ E2 STA1 HR4	17-Aug-00	14:47	EBB	2703878	815379	Sampling HR4 - Station1 (50ft)	26.0	29.0	27.5	39			
NBPDWQ E2 STA2 HR4	17-Aug-00	14:53	EBB	2703625	815534	Sampling HR4 - Station 2 (300ft)	19.0	26.0	22.5	31			
NBPDWQ E2 STA3 HR4	17-Aug-00	14:57	EBB	2703218	815599	Sampling HR4 - Station 3 (700ft)	27.0	29.0	28.0	37			
NBPDWQ E2 STA4 HR4	17-Aug-00	15:03	EBB	2702964	815758	Sampling HR4 - Station 4 (1000ft)	13.0	18.0	15.5	22			
NBPDWQ E2 STA01	17-Aug-00		COMPOSITE			Composite - Station 1	10.0	16.0	12.0	19	2.00	2.70	4.70
NBPDWQ E2 STA02	17-Aug-00		COMPOSITE			Composite - Station 2	21.0	29.0	25.0	21	2.20	0.83	3.03
NBPDWQ E2 STA03	17-Aug-00		COMPOSITE			Composite - Station 3	18.0	24.0	21.0	18	1.30	0.79	2.09
NBPDWQ E2 STA04	17-Aug-00		COMPOSITE			Composite - Station 4	20.0	24.0	22.0	15	1.00	0.67	1.67
NBPDWQ E2 STA05	17-Aug-00		COMPOSITE			Composite - REF	13.0	18.0	15.5	6	0.61	0.78	1.39
NBPDWQ F2 STA1 HR1	17-Aug-00	16:49	FLOOD	2704000	815321	Sampling HR1 - Station1 (50ft)	13.0	16.0	14.5	17			
NBPDWQ F2 STA2 HR1	17-Aug-00	17:06	FLOOD	2704266	815441	Sampling HR1 - Station 2 (300ft)	14.0	19.0	16.5	20			
NBPDWQ F2 STA3 HR1	17-Aug-00	17:12	FLOOD	2704727	815455	Sampling HR1 - Station 3 (700ft)	60.0	70.0	65.0	210			
NBPDWQ F2 STA4 HR1	17-Aug-00	17:18	FLOOD	2705097	815357	Sampling HR1 - Station 4 (1000ft)	10.0	13.0	11.5	10			
NBPDWQ F2 STA5 HR1	17-Aug-00	17:33	FLOOD	2702805	815548	Sampling HR1 - Station 5 (1000ft-up-current)	6.0	13.0	9.5	9			
NBPDWQ F2 STA1 HR2	17-Aug-00	18:00	FLOOD	2704000	815321	Sampling HR2 - Station1 (50ft)	6.0	13.0	9.5	8			
NBPDWQ F2 STA2 HR2	17-Aug-00	18:06	FLOOD	2704266	815441	Sampling HR2 - Station 2 (300ft)	15.0	18.0	16.5	15			
NBPDWQ F2 STA3 HR2	17-Aug-00	18:12	FLOOD	2704727	815455	Sampling HR2 - Station 3 (700ft)	11.0	19.0	15.0	16			
NBPDWQ F2 STA4 HR2	17-Aug-00	18:15	FLOOD	2705097	815357	Sampling HR2 - Station 4 (1000ft)	12.0	17.0	14.5	14			
NBPDWQ F2 STA5 HR2	17-Aug-00	18:30	FLOOD	2702805	815548	Sampling HR2 - REF (1000ft-up-current)	11.0	13.0	12.0	6			
NBPDWQ F2 STA1 HR3	17-Aug-00	19:04	FLOOD	2704000	815321	Sampling HR3 - Station1 (50ft)	12.0	15.0	13.5	13			
NBPDWQ F2 STA2 HR3	17-Aug-00	19:08	FLOOD	2704266	815441	Sampling HR3 - Station 2 (300ft)	11.0	16.0	13.5	20			
NBPDWQ F2 STA3 HR3	17-Aug-00	19:12	FLOOD	2704727	815455	Sampling HR3 - Station 3 (700ft)	8.0	13.0	10.5	11			
NBPDWQ F2 STA4 HR3	17-Aug-00	19:16	FLOOD	2705097	815357	Sampling HR3 - Station 4 (1000ft)	12.0	19.0	15.5	19			
NBPDWQ F2 STA5 HR3	17-Aug-00	19:33	FLOOD	2702805	815548	Sampling HR3 - REF (1000ft-up-current)	4.0	9.0	6.5	3			
NBPDWQ F2 STA01	17-Aug-00		COMPOSITE			Composite - Station 1				11	0.91	0.55	1.46
NBPDWQ F2 STA02	17-Aug-00		COMPOSITE			Composite - Station 2				16	1.60	0.77	2.37
NBPDWQ F2 STA03	17-Aug-00		COMPOSITE			Composite - Station 3				18	2.60	0.95	3.55
NBPDWQ F2 STA04	17-Aug-00		COMPOSITE			Composite - Station 4				12	1.10	0.92	2.02
NBPDWQ F2 STA05	17-Aug-00		COMPOSITE			Composite - REF				6	0.39	0.56	0.95
NBH0818-R1 TSS	18-Aug-00	10:48	Grab			Sample Up-current-reference (Event scrubbed)	10.0	15.0	12.5	6	0.13	0.22	0.35
NBH0818-Moon TSS	18-Aug-00	17:44	Grab			Sample inside moonpool during active dredging	44.0	50.0	47.0	120	23.00	4.60	27.60

Figure K-22 - Particulate PCB Data

Field ID	E1-STA01	E1-STA02	E1-STA03	E1-STA04	Equipment Blank	F1-STA01 Comp	F1-STA02 Comp
Lab ID	44730-11	44730-12	44730-13	44730-14	44747-18	44730-15	44730-16
Matrix	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE
Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
PCB Congener							
8 - 2,4'-Dichlorobiphenyl	0.045	0.069	0.025	0.023	0.0018 U	0.11	0.023
18 - 2,2',5-Trichlorobiphenyl	0.13	0.17	0.081	0.084	0.0018 U	0.24	0.089
28 - 2,4,4'-Trichlorobiphenyl	0.27	0.48	0.18	0.26	0.0044 U	0.68	0.21
44 - 2,2',3,5'-Tetrachlorobiphenyl	0.096	0.14	0.069	0.047	0.0018 U	0.17	0.069
52 - 2,2',5,5'-Tetrachlorobiphenyl	0.28	0.44	0.17	0.16	0.0018 U	0.56	0.2
66 - 2,3',4,4'-Tetrachlorobiphenyl	0.11	0.18	0.08	0.065	0.0024	0.24	0.082
101 - 2,2',4,5,5'-Pentachlorobiphenyl	0.089	0.16	0.07	0.084	0.0047 U	0.17	0.067
105 - 2,3,3',4,4'-Pentachlorobiphenyl	0.01	0.023	0.0091	0.0065	0.0018 U	0.016	0.01
118 - 2,3',4,4',5-Pentachlorobiphenyl	0.082	0.14	0.063	0.081	0.0018 U	0.18	0.11
128 - 2,2',3,3',4,4'-Hexachlorobiphenyl	0.0086	0.016	0.0068 U	0.0044	0.0018 U	0.012	0.0077
138 - 2,2',3,4,4',5'-Hexachlorobiphenyl	0.054	0.072	0.041	0.024	0.0018 U	0.078	0.043
153 - 2,2',4,4',5,5'-Hexachlorobiphenyl	0.076	0.14	0.055	0.045	0.0018 U	0.15	0.06
170 - 2,2',3,3',4,4',5-Heptachlorobiphenyl	0.0072	0.013	0.0068 U	0.0029	0.0018 U	0.0084	0.0061
180 - 2,2',3,4,4',5,5'-Heptachlorobiphenyl	0.0072	0.0034 U	0.0068 U	0.0021 U	0.0021 U	0.0073 U	0.0059
187 - 2,2',3,4',5,5',6-Heptachlorobiphenyl	0.011	0.017	0.0074	0.0052	0.0018 U	0.008	0.0086
195 - 2,2',3,3',4,4',5,6-Octachlorobiphenyl	0.0014 U	0.0034 U	0.0068 U	0.0014 U	0.0018 U	0.0073 U	0.0014 U
206 - 2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	0.0014 U	0.0034 U	0.0068 U	0.0014 U	0.0018 U	0.0073 U	0.0014 U
209 - 2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	0.0014 U	0.0034 U	0.0068 U	0.0014 U	0.0018 U	0.0073 U	0.0014 U
NOAA Congener Total ppb	1.3	2.1	0.85	0.89	0.0024	2.6	0.99

Qualifiers and Notes
U = congener is not detected above the MDL
J = congener concentration is estimated

All results are surrogate corrected using PCB 198

Figure K-22 - Particulate PCB Data (Continued)

Field ID	F1-STA03	F1-STA04	NBH0816-R1 PCB	NBH0817-1345 PCB	NBH0818-MOON	NBH0818-R1 PCB	NBH817-R1 PCB
Lab ID	44730-19	44730-20	44730-18	44747-26	44750-06	44750-08	44747-24
Matrix	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE
Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
PCB Congener							
8 - 2,4'-Dichlorobiphenyl	0.029	0.0066	0.0022	2.5	2	0.0021	0.012
18 - 2,2',5-Trichlorobiphenyl	0.099	0.028	0.0057	3.2	2.1	0.015	0.03
28 - 2,4,4'-Trichlorobiphenyl	0.22	0.061	0.022	8.2	5.6	0.031	0.071
44 - 2,2',3,5'-Tetrachlorobiphenyl	0.073	0.019	0.0097	1.6	2	0.011	0.02
52 - 2,2',5,5'-Tetrachlorobiphenyl	0.22	0.054	0.026	5.2	5.6	0.03	0.054
66 - 2,3',4,4'-Tetrachlorobiphenyl	0.088	0.025	0.014	2.1	1.7	0.016	0.031
101 - 2,2',4,5,5'-Pentachlorobiphenyl	0.14	0.032 U	0.0225 U	1 U	0.64	0.026 U	0.022 U
105 - 2,3,3',4,4'-Pentachlorobiphenyl	0.012	0.0036	0.0027	0.11 U	0.088	0.0029	0.003
118 - 2,3',4,4',5-Pentachlorobiphenyl	0.12	0.026	0.017	1.1	1.2	0.0045	0.038
128 - 2,2',3,3',4,4'-Hexachlorobiphenyl	0.0089	0.0015 U	0.0015 U	0.11 U	0.089 J	0.0015 U	0.0017 U
138 - 2,2',3,4,4',5'-Hexachlorobiphenyl	0.048	0.0087	0.006	0.55 J	0.65 J	0.0071	0.01 J
153 - 2,2',4,4',5,5'-Hexachlorobiphenyl	0.067	0.014	0.0079	1.1	1.1	0.0083	0.019
170 - 2,2',3,3',4,4',5-Heptachlorobiphenyl	0.0072	0.0015 U	0.0015 U	0.11 U	0.11 J	0.002	0.0017 U
180 - 2,2',3,4,4',5,5'-Heptachlorobiphenyl	0.0065	0.0021 U	0.0021 U	0.11 U	0.056 U	0.0021 U	0.0021 U
187 - 2,2',3,4',5,5',6-Heptachlorobiphenyl	0.0093	0.0015 U	0.0015 U	0.11 U	0.14	0.0015 U	0.0017 U
195 - 2,2',3,3',4,4',5,6-Octachlorobiphenyl	0.0014 U	0.0015 U	0.0015 U	0.11 U	0.056 U	0.0015 U	0.0017 U
206 - 2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	0.0014 U	0.0015 U	0.0015 U	0.11 U	0.056 U	0.0015 U	0.0017 U
209 - 2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	0.0014 U	0.0015 U	0.0015 U	0.11 U	0.056 U	0.0015 U	0.0017 U
NOAA Congener Total ppb	1.1	0.25	0.11	26	23	0.13	0.29

Qualifiers and Notes
U = congener is not detected above the MDL
J = congener concentration is estimated

All results are surrogate corrected using PCB 198

Figure K-22 - Particulate PCB Data (Continued)

Field ID	NBHPDWQ-Slick-1	NBPDWQ E2 STA01	NBPDWQ E2 STA02	NBPDWQ E2 STA03	NBPDWQ E2 STA04	NBPDWQ E2 STA05
Lab ID	44751-02	44747-19	44747-20	44747-21	44747-22	44747-23
Matrix	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE
Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
PCB Congener						
8 - 2,4'-Dichlorobiphenyl	0.12	0.066	0.092	0.042	0.03	0.019
18 - 2,2',5-Trichlorobiphenyl	0.23	0.14	0.18	0.11	0.088	0.081
28 - 2,4,4'-Trichlorobiphenyl	0.58	0.59	0.7	0.27	0.22 J	0.15
44 - 2,2',3,5'-Tetrachlorobiphenyl	0.16	0.11	0.14	0.093	0.076 J	0.046
52 - 2,2',5,5'-Tetrachlorobiphenyl	0.48	0.36	0.4	0.25	0.21	0.13
66 - 2,3',4,4'-Tetrachlorobiphenyl	0.19	0.14	0.19	0.12	0.1 J	0.053
101 - 2,2',4,5,5'-Pentachlorobiphenyl	0.11 U	0.17	0.21 U	0.079	0.07 U	0.035 U
105 - 2,3,3',4,4'-Pentachlorobiphenyl	0.011	0.014	0.017	0.013	0.011	0.0051
118 - 2,3',4,4',5-Pentachlorobiphenyl	0.16	0.19	0.25	0.15	0.13	0.062
128 - 2,2',3,3',4,4'-Hexachlorobiphenyl	0.009	0.02	0.008 U	0.01	0.0092	0.0034
138 - 2,2',3,4,4',5'-Hexachlorobiphenyl	0.064 J	0.079 J	0.084 J	0.057 J	0.044 J	0.019 J
153 - 2,2',4,4',5,5'-Hexachlorobiphenyl	0.13	0.1	0.12	0.076	0.064	0.033
170 - 2,2',3,3',4,4',5-Heptachlorobiphenyl	0.0073 U	0.011	0.008 U	0.01	0.0085 J	0.0019
180 - 2,2',3,4,4',5,5'-Heptachlorobiphenyl	0.0073 U	0.0032 U	0.008 U	0.0021	0.0021 U	0.0021 U
187 - 2,2',3,4',5,5',6-Heptachlorobiphenyl	0.0073 U	0.012	0.008 U	0.011	0.011	0.003
195 - 2,2',3,3',4,4',5,6-Octachlorobiphenyl	0.0073 U	0.0032 U	0.008 U	0.0014 U	0.0012 U	0.0016 U
206 - 2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	0.0073 U	0.0032 U	0.008 U	0.0014 U	0.0012 U	0.0016 U
209 - 2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	0.0073 U	0.0032 U	0.008 U	0.0014 U	0.0013 U	0.0016 U
NOAA Congener Total ppb	2.1	2.0	2.2	1.3	1.0	0.61

Qualifiers and Notes
U = congener is not detected above the MDL
J = congener concentration is estimated

All results are surrogate corrected using PCB 198

Figure K-22 - Particulate PCB Data (Continued)

Field ID	NBPDWQ F2 STA01	NBPDWQ F2 STA02	NBPDWQ F2 STA03	NBPDWQ F2 STA04	NBPDWQ F2 STA05	NBPDWQ1000N	NBPDWQ1000S
Lab ID	44747-13	44747-14	44747-15	44747-16	44747-17	44673-13	44673-16
Matrix	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE	PARTICULATE
Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
PCB Congener							
8 - 2,4'-Dichlorobiphenyl	0.031	0.083	0.12	0.042	0.019	0.036	0.0036
18 - 2,2',5-Trichlorobiphenyl	0.096	0.16	0.21	0.13	0.043	0.093	0.017
28 - 2,4,4'-Trichlorobiphenyl	0.23	0.43	0.83	0.29	0.1	0.19	0.038
44 - 2,2',3,5'-Tetrachlorobiphenyl	0.068	0.11	0.16	0.009	0.03	0.066	0.018
52 - 2,2',5,5'-Tetrachlorobiphenyl	0.17	0.32	0.44	0.22	0.073	0.18	0.045
66 - 2,3',4,4'-Tetrachlorobiphenyl	0.084	0.13	0.19	0.097	0.036	0.072	0.031
101 - 2,2',4,5,5'-Pentachlorobiphenyl	0.064 U	0.1	0.22	0.074 U	0.025 U	0.095	0.041
105 - 2,3,3',4,4'-Pentachlorobiphenyl	0.0089	0.013	0.015	0.011	0.0032	0.0084	0.0045
118 - 2,3',4,4',5-Pentachlorobiphenyl	0.11	0.084	0.22	0.13	0.045	0.059	0.02
128 - 2,2',3,3',4,4'-Hexachlorobiphenyl	0.007	0.01	0.0093	0.009	0.002	0.0054	0.0019
138 - 2,2',3,4,4',5'-Hexachlorobiphenyl	0.036 J	0.05 J	0.1 J	0.042 J	0.014 J	0.029	0.01
153 - 2,2',4,4',5,5'-Hexachlorobiphenyl	0.054	0.089	0.12	0.066	0.023	0.049	0.016
170 - 2,2',3,3',4,4',5-Heptachlorobiphenyl	0.0041	0.013	0.012	0.0061	0.0014 U	0.0029	0.0015 U
180 - 2,2',3,4,4',5,5'-Heptachlorobiphenyl	0.0021 U	0.0031 U	0.0085 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U
187 - 2,2',3,4',5,5',6-Heptachlorobiphenyl	0.007	0.011	0.0085 U	0.0089	0.0016	0.0064	0.0015 U
195 - 2,2',3,3',4,4',5,6-Octachlorobiphenyl	0.0014 U	0.0031 U	0.0085 U	0.0015 U	0.0014 U	0.0015 U	0.0015 U
206 - 2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	0.0014 U	0.0031 U	0.0085 U	0.0015 U	0.0014 U	0.0015 U	0.0015 U
209 - 2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	0.0014 U	0.0031 U	0.0085 U	0.0015 U	0.0014 U	0.0015 U	0.0015 U
NOAA Congener Total ppb	0.91	1.6	2.6	1.1	0.39	0.89	0.25

Qualifiers and Notes
U = congener is not detected above the MDL
J = congener concentration is estimated

All results are surrogate corrected using PCB 198

Figure K-23 - Dissolved PCB Data

Field ID	E1-STA01	E1-STA02	E1-STA03	E1-STA04	Equipment Blank	F1-STA01 Comp	F1-STA02 Comp	F1-STA03
Lab ID	44730-01	44730-02	44730-03	44730-04	44747-06	44730-05	44730-06	44730-09
Matrix	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
PCB Congener								
8 - 2,4'-Dichlorobiphenyl	0.12	0.11	0.11	0.12	0.007	0.063	0.076	0.048
18 - 2,2',5-Trichlorobiphenyl	0.2	0.17	0.19	0.25	0.009	0.17	0.16	0.14
28 - 2,4,4'-Trichlorobiphenyl	0.23	0.2	0.22	0.25	0.016	0.17	0.16	0.15
44 - 2,2',3,5'-Tetrachlorobiphenyl	0.049	0.056	0.048	0.05	0.002	0.043	0.041	0.039
52 - 2,2',5,5'-Tetrachlorobiphenyl	0.12	0.13	0.12	0.16	0.007	0.11	0.097	0.094
66 - 2,3',4,4'-Tetrachlorobiphenyl	0.036	0.04	0.034	0.042	0.004	0.03	0.034	0.033
101 - 2,2',4,5,5'-Pentachlorobiphenyl	0.014 U	0.041	0.015 U	0.011 U	0.011 U	0.039	0.012 U	0.0056 U
105 - 2,3,3',4,4'-Pentachlorobiphenyl	0.0026	0.0029	0.004	0.0037	0.0016 U	0.0026	0.0022	0.0021
118 - 2,3',4,4',5-Pentachlorobiphenyl	0.0058	0.013	0.012	0.012	0.0016 U	0.011	0.0076	0.01
128 - 2,2',3,3',4,4'-Hexachlorobiphenyl	0.0017 U	0.0012	0.0017 U	0.002 U	0.0016 U	0.002 U	0.0021 U	0.0018 U
138 - 2,2',3,4,4',5'-Hexachlorobiphenyl	0.0017 U	0.0088	0.0024	0.0029	0.0016 U	0.0054	0.0021 U	0.0021
153 - 2,2',4,4',5,5'-Hexachlorobiphenyl	0.0034	0.013	0.0073	0.0076	0.0016 U	0.011	0.0044	0.0049
170 - 2,2',3,3',4,4',5-Heptachlorobiphenyl	0.0017 U	0.001 U	0.0017 U	0.002 U	0.0016 U	0.0018 U	0.0021 U	0.0018 U
180 - 2,2',3,4,4',5,5'-Heptachlorobiphenyl	0.0017 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U
187 - 2,2',3,4',5,5',6-Heptachlorobiphenyl	0.0017 U	0.0011	0.0017 U	0.002 U	0.0016 U	0.0018 U	0.0021 U	0.0018 U
195 - 2,2',3,3',4,4',5,6-Octachlorobiphenyl	0.0017 U	0.001 U	0.0017 U	0.002 U	0.0016 U	0.0018 U	0.0021 U	0.0018 U
206 - 2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	0.0017 U	0.001 U	0.0017 U	0.002 U	0.0016 U	0.0018 U	0.0021 U	0.0018 U
209 - 2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	0.0017 U	0.001 U	0.0017 U	0.002 U	0.0016 U	0.0018 U	0.0021 U	0.0018 U
NOAA Congener Total ppb	0.77	0.79	0.75	0.90	0.045	0.66	0.58	0.52

Qualifiers and Notes
U = congener is not detected above the MDL
J = congener concentration is estimated

All results are surrogate corrected using PCB 198

Figure K-23 - Dissolved PCB Data (Continued)

Field ID	F1-STA04	NBH0816-R1 PCB	NBH0817-1345 PCB	NBH0818-MOON	NBH0818-R1 PCB	NBH817-R1 PCB	NBHPDWQ-Slick-1
Lab ID	44730-10	44730-08	44747-25	44750-02	44750-04	44747-12	44751-01
Matrix	WATER	WATER	WATER	WATER	WATER	WATER	WATER
Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
PCB Congener							
8 - 2,4'-Dichlorobiphenyl	0.043	0.017	0.85	1.2	0.028	0.043	0.11
18 - 2,2',5-Trichlorobiphenyl	0.094	0.055	0.69	0.66	0.058	0.11	0.14
28 - 2,4,4'-Trichlorobiphenyl	0.12	0.07	0.74	1.2	0.076	0.15	0.17
44 - 2,2',3,5'-Tetrachlorobiphenyl	0.026	0.015	0.089	0.33 J	0.013	0.033	0.032
52 - 2,2',5,5'-Tetrachlorobiphenyl	0.068	0.041	0.29	0.76	0.038	0.09	0.091
66 - 2,3',4,4'-Tetrachlorobiphenyl	0.022 U	0.015 U	0.023	0.22 J	0.013 U	0.024	0.012 U
101 - 2,2',4,5,5'-Pentachlorobiphenyl	0.012 U	0.015 U	0.043	0.085	0.0017 U	0.024 U	0.01 U
105 - 2,3,3',4,4'-Pentachlorobiphenyl	0.0018	0.0017	0.011 U	0.02 U	0.0017 U	0.0021 U	0.0023 U
118 - 2,3',4,4',5-Pentachlorobiphenyl	0.0066	0.0059	0.022	0.053	0.005	0.005	0.005
128 - 2,2',3,3',4,4'-Hexachlorobiphenyl	0.0017 U	0.0016 U	0.011 U	0.02 U	0.0017 U	0.0021 U	0.0023 U
138 - 2,2',3,4,4',5'-Hexachlorobiphenyl	0.0017 U	0.0016 U	0.011 U	0.03 J	0.0017 U	0.0021 U	0.0023 U
153 - 2,2',4,4',5,5'-Hexachlorobiphenyl	0.0024	0.0016 U	0.011 U	0.072 J	0.0017 U	0.0021 U	0.0023 U
170 - 2,2',3,3',4,4',5-Heptachlorobiphenyl	0.0017 U	0.0016 U	0.011 U	0.02 U	0.0017 U	0.003	0.0023 U
180 - 2,2',3,4,4',5,5'-Heptachlorobiphenyl	0.0021 U	0.0021 U	0.011 U	0.02 U	0.0021 U	0.0021 U	0.0023 U
187 - 2,2',3,4',5,5',6-Heptachlorobiphenyl	0.0017 U	0.0016 U	0.011 U	0.02 U	0.0017 U	0.0021 U	0.0023 U
195 - 2,2',3,3',4,4',5,6-Octachlorobiphenyl	0.0017 U	0.0016 U	0.011 U	0.02 U	0.0017 U	0.0021 U	0.0023 U
206 - 2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	0.0017 U	0.0016 U	0.011 U	0.02 U	0.0017 U	0.0021 U	0.0023 U
209 - 2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	0.0017 U	0.0016 U	0.011 U	0.02 U	0.0017 U	0.0021 U	0.0023 U
NOAA Congener Total ppb	0.36	0.21	2.7	4.6	0.22	0.46	0.55

Qualifiers and Notes
U = congener is not detected above the MDL
J = congener concentration is estimated

All results are surrogate corrected using PCB ·

Figure K-23 - Dissolved PCB Data (Continued)

Field ID	**NBPD-EB-D1**	**NBPDWQ E2 STA01**	**NBPDWQ E2 STA02**	**NBPDWQ E2 STA03**	**NBPDWQ E2 STA04**	**NBPDWQ E2 STA05**	**NBPDWQ F2 STA01**
Lab ID	**44730-07**	**44747-07**	**44747-08**	**44747-09**	**44747-10**	**44747-11**	**44747-01**
Matrix	**WATER**	**WATER**	**WATER**	**WATER**	**WATER**	**WATER**	**WATER**
Units	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
PCB Congener							
8 - 2,4'-Dichlorobiphenyl	0.0016 U	0.25	0.12	0.12	0.082	0.1	0.064
18 - 2,2',5-Trichlorobiphenyl	0.002	0.38	0.17	0.17	0.14	0.2	0.15
28 - 2,4,4'-Trichlorobiphenyl	0.0066	0.56	0.25	0.26	0.22	0.24	0.17
44 - 2,2',3,5'-Tetrachlorobiphenyl	0.0016 U	0.87	0.054	0.051	0.044 J	0.047	0.036
52 - 2,2',5,5'-Tetrachlorobiphenyl	0.0058	0.35	0.14	0.14	0.12	0.15	0.086
66 - 2,3',4,4'-Tetrachlorobiphenyl	0.0043	0.11	0.042	0.04	0.035	0.035	0.03
101 - 2,2',4,5,5'-Pentachlorobiphenyl	0.0058	0.066	0.029	0.023 U	0.012 U	0.012 U	0.015 U
105 - 2,3,3',4,4'-Pentachlorobiphenyl	0.0016 U	0.0041 U	0.002 U	0.0021 U	0.002 U	0.0019 U	0.0019 U
118 - 2,3',4,4',5-Pentachlorobiphenyl	0.0016 U	0.053	0.018	0.005	0.011	0.006	0.007
128 - 2,2',3,3',4,4'-Hexachlorobiphenyl	0.0016 U	0.023	0.002 U	0.0021 U	0.002 U	0.0019 U	0.0019 U
138 - 2,2',3,4,4',5'-Hexachlorobiphenyl	0.0016 U	0.023	0.003	0.0021 U	0.002 U	0.0019 U	0.0024
153 - 2,2',4,4',5,5'-Hexachlorobiphenyl	0.0016 U	0.045	0.007	0.0021 U	0.002 U	0.0019 U	0.0049
170 - 2,2',3,3',4,4',5-Heptachlorobiphenyl	0.0016 U	0.0041 U	0.002 U	0.004	0.017	0.0019 U	0.0019 U
180 - 2,2',3,4,4',5,5'-Heptachlorobiphenyl	0.0021 U	0.0041 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U
187 - 2,2',3,4',5,5',6-Heptachlorobiphenyl	0.0016 U	0.0041 U	0.002 U	0.0021 U	0.002 U	0.0019 U	0.0019 U
195 - 2,2',3,3',4,4',5,6-Octachlorobiphenyl	0.0016 U	0.0041 U	0.002 U	0.0021 U	0.002 U	0.0019 U	0.0019 U
206 - 2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	0.0016 U	0.0041 U	0.002 U	0.0021 U	0.002 U	0.0019 U	0.0019 U
209 - 2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	0.0016 U	0.0041 U	0.002 U	0.0021 U	0.002 U	0.0019 U	0.0019 U
NOAA Congener Total ppb	0.025	2.7	0.83	0.79	0.67	0.78	0.55

Qualifiers and Notes
U = congener is not detected above the MDL
J = congener concentration is estimated

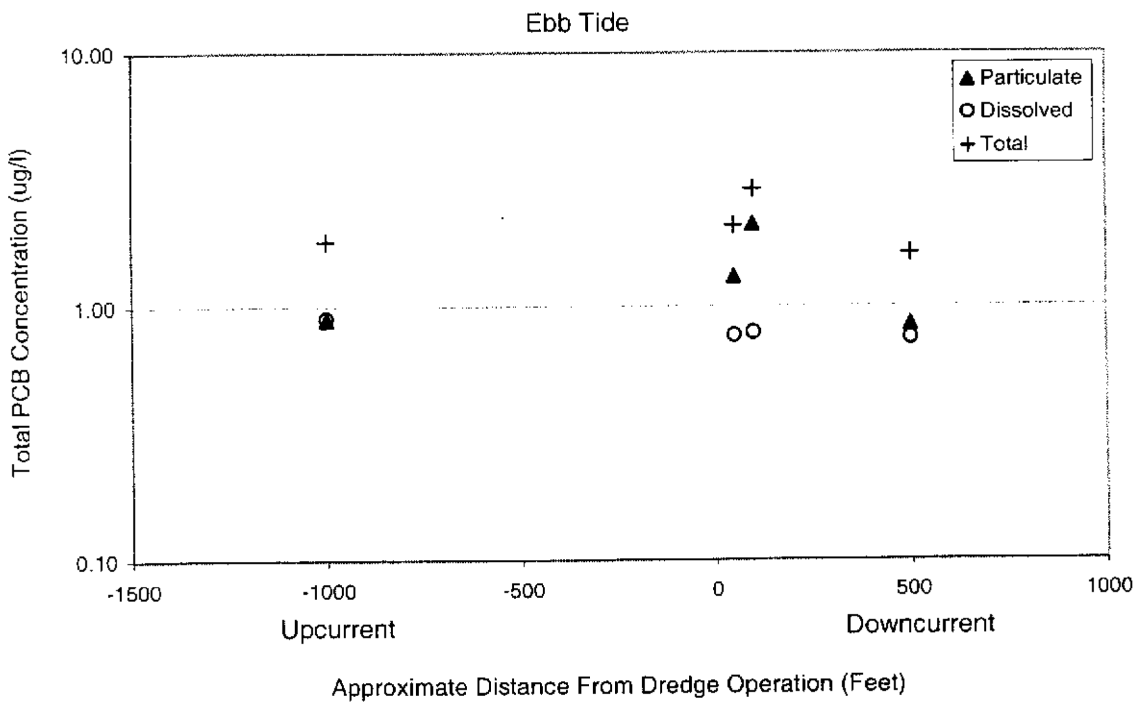
All results are surrogate corrected using PCB ·

Figure K-23 - Dissolved PCB Data (Continued)

Field ID	NBPDWQ F2 STA02	NBPDWQ F2 STA03	NBPDWQ F2 STA04	NBPDWQ F2 STA05	NBPDWQ1000N Diss.	NBPDWQ1000S	NBPDWQ-SLICK-2
Lab ID	44747-02	44747-03	44747-04	44747-05	44673-07	44673-10	44730-29
Matrix	WATER	WATER	WATER	WATER	WATER	WATER	WATER
Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
PCB Congener							
8 - 2,4'-Dichlorobiphenyl	0.12	0.17	0.15	0.08	0.11	0.0027	0.13
18 - 2,2',5-Trichlorobiphenyl	0.2	0.22	0.23	0.14	0.12	0.045	0.25
28 - 2,4,4'-Trichlorobiphenyl	0.25	0.3	0.28	0.18	0.12	0.056	0.39
44 - 2,2',3,5'-Tetrachlorobiphenyl	0.05	0.061	0.055	0.034	0.031	0.012	0.094
52 - 2,2',5,5'-Tetrachlorobiphenyl	0.12	0.15	0.15	0.089	0.072	0.032	0.26
66 - 2,3',4,4'-Tetrachlorobiphenyl	0.025	0.028	0.043	0.026	0.024	0.013	0.098
101 - 2,2',4,5,5'-Pentachlorobiphenyl	0.026 U	0.01 U	0.012 U	0.022 U	0.026	0.017	0.11
105 - 2,3,3',4,4'-Pentachlorobiphenyl	0.0021 U	0.0021 U	0.0024 U	0.002 U	0.0023	0.0016 U	0.0064
118 - 2,3',4,4',5-Pentachlorobiphenyl	0.0095	0.015	0.008	0.006	0.0076	0.0023	0.089
128 - 2,2',3,3',4,4'-Hexachlorobiphenyl	0.0021 U	0.0021 U	0.0024 U	0.002 U	0.0019 U	0.0016 U	0.0035
138 - 2,2',3,4,4',5'-Hexachlorobiphenyl	0.0021 U	0.0021	0.0024 U	0.002 U	0.0023	0.0016 U	0.03
153 - 2,2',4,4',5,5'-Hexachlorobiphenyl	0.0021 U	0.003	0.0024 U	0.002 U	0.0052	0.0016 U	0.042
170 - 2,2',3,3',4,4',5-Heptachlorobiphenyl	0.0021 U	0.0021 U	0.0024 U	0.002 U	0.0019 U	0.0016 U	0.0027
180 - 2,2',3,4,4',5,5'-Heptachlorobiphenyl	0.0021 U	0.0021 U	0.0024 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U
187 - 2,2',3,4',5,5',6-Heptachlorobiphenyl	0.0021 U	0.0021 U	0.0024 U	0.002 U	0.0019 U	0.0016 U	0.0046
195 - 2,2',3,3',4,4',5,6-Octachlorobiphenyl	0.0021 U	0.0021 U	0.0024 U	0.002 U	0.0019 U	0.0016 U	0.002 U
206 - 2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	0.0021 U	0.0021 U	0.0024 U	0.002 U	0.0019 U	0.0016 U	0.002 U
209 - 2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	0.0021 U	0.0021 U	0.0024 U	0.002 U	0.0019 U	0.0016 U	0.002 U
NOAA Congener Total ppb	0.77	0.95	0.92	0.56	0.52	0.18	1.5

Qualifiers and Notes
U = congener is not detected above the MDL
J = congener concentration is estimated

All results are surrogate corrected using PCB ·



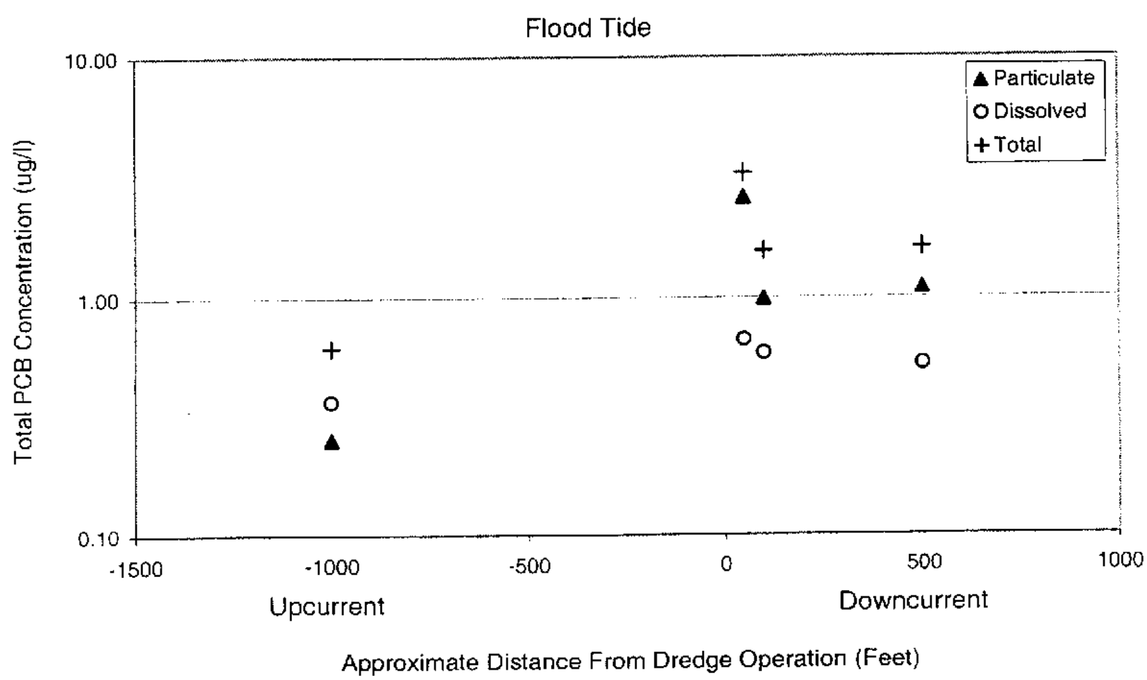
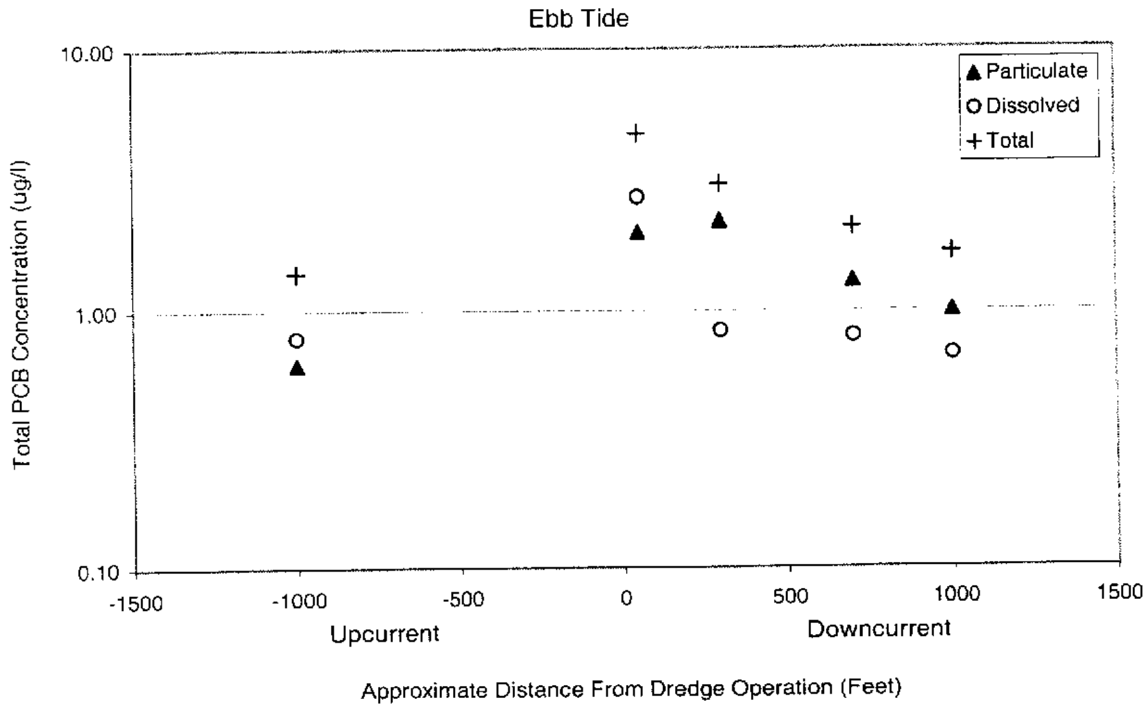


FIGURE K-24

Total PCB Concentrations (Sum of 18 Congeners) in Composite Samples for 16 August Monitoring Events



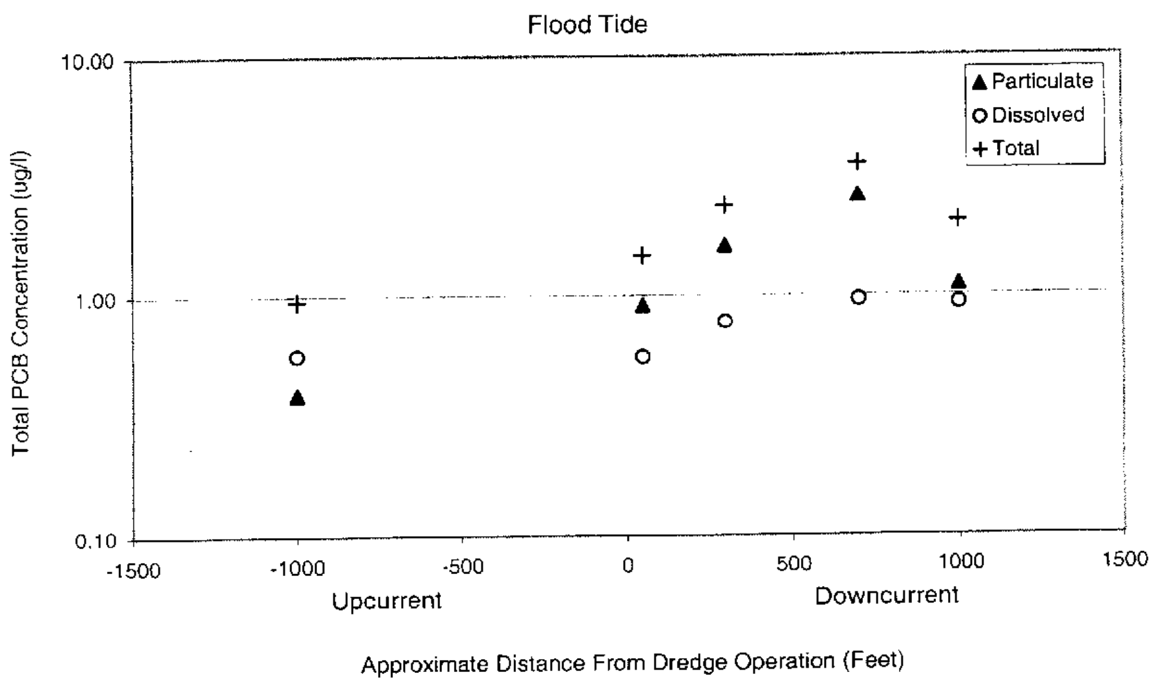


FIGURE K-25

Total PCB Concentrations (Sum of 18 Congeners) in Composite Samples for 17 August Monitoring Events

M010066

FIGURE K-26
Aerial View of Support Vessel and Dredging Operations

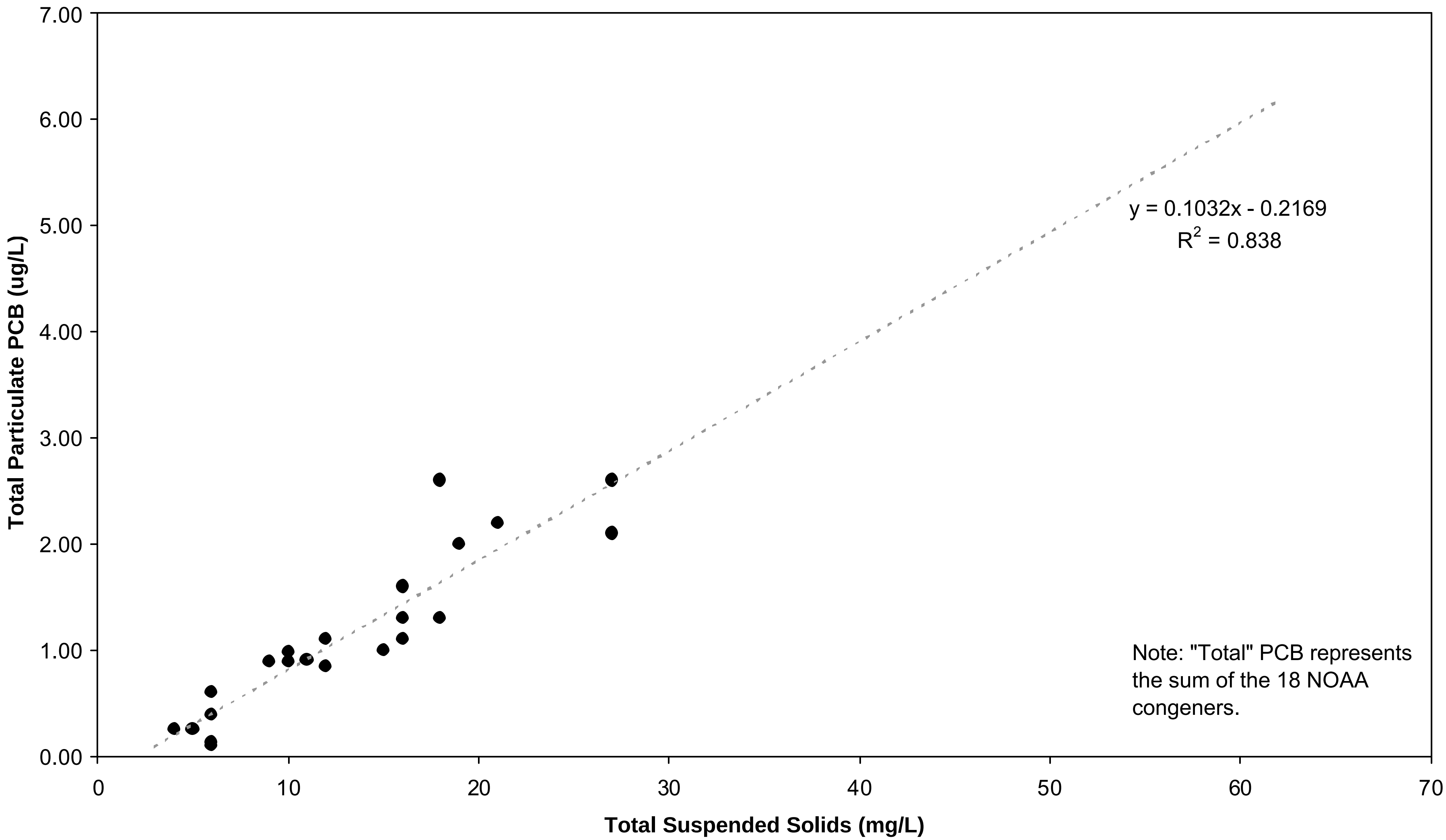


Figure K-27: Correlation between Total Suspended Solids and Total Particulate PCB

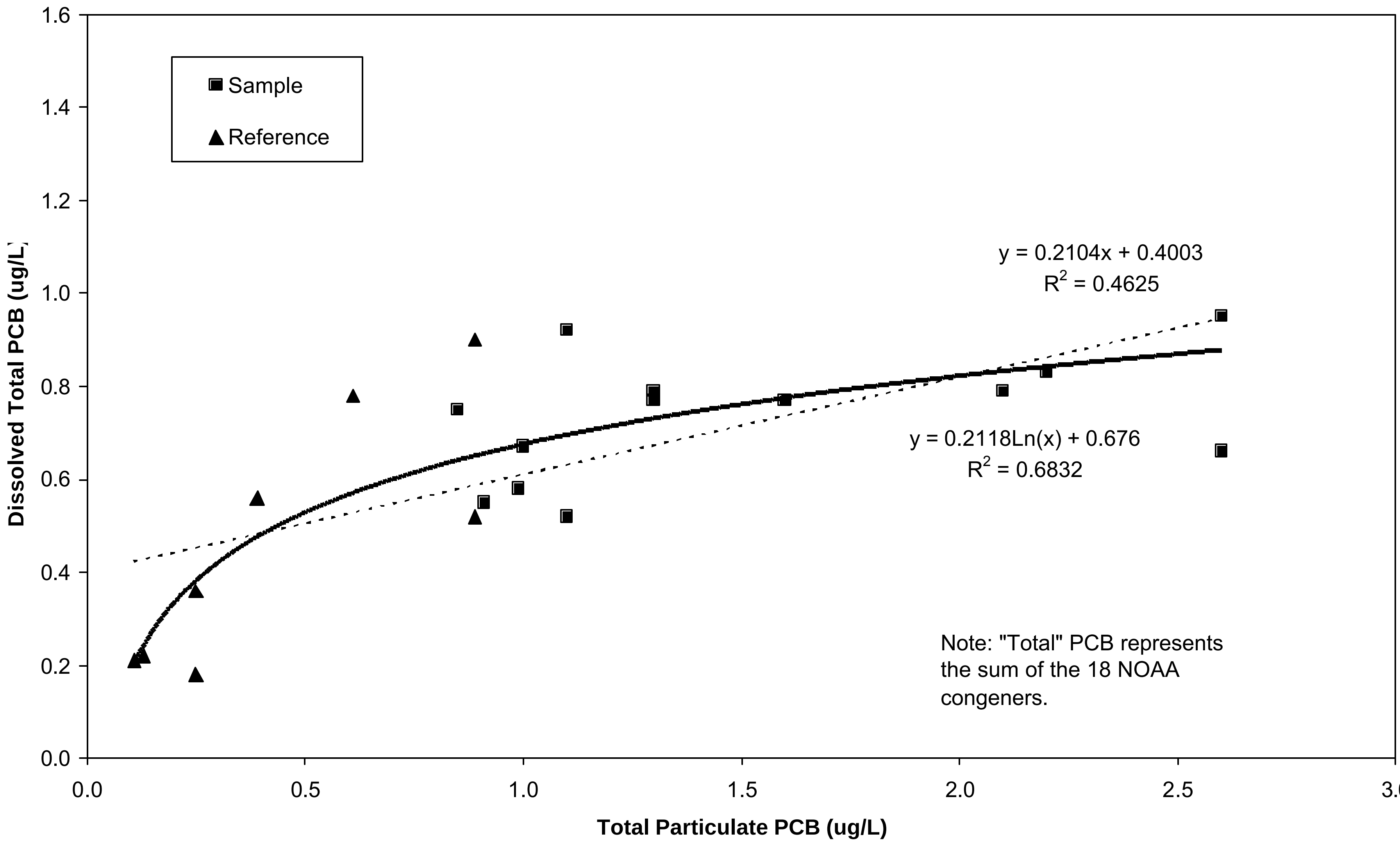


Figure K-28: Correlation between Total Particulate PCB and Total Dissolved PCB

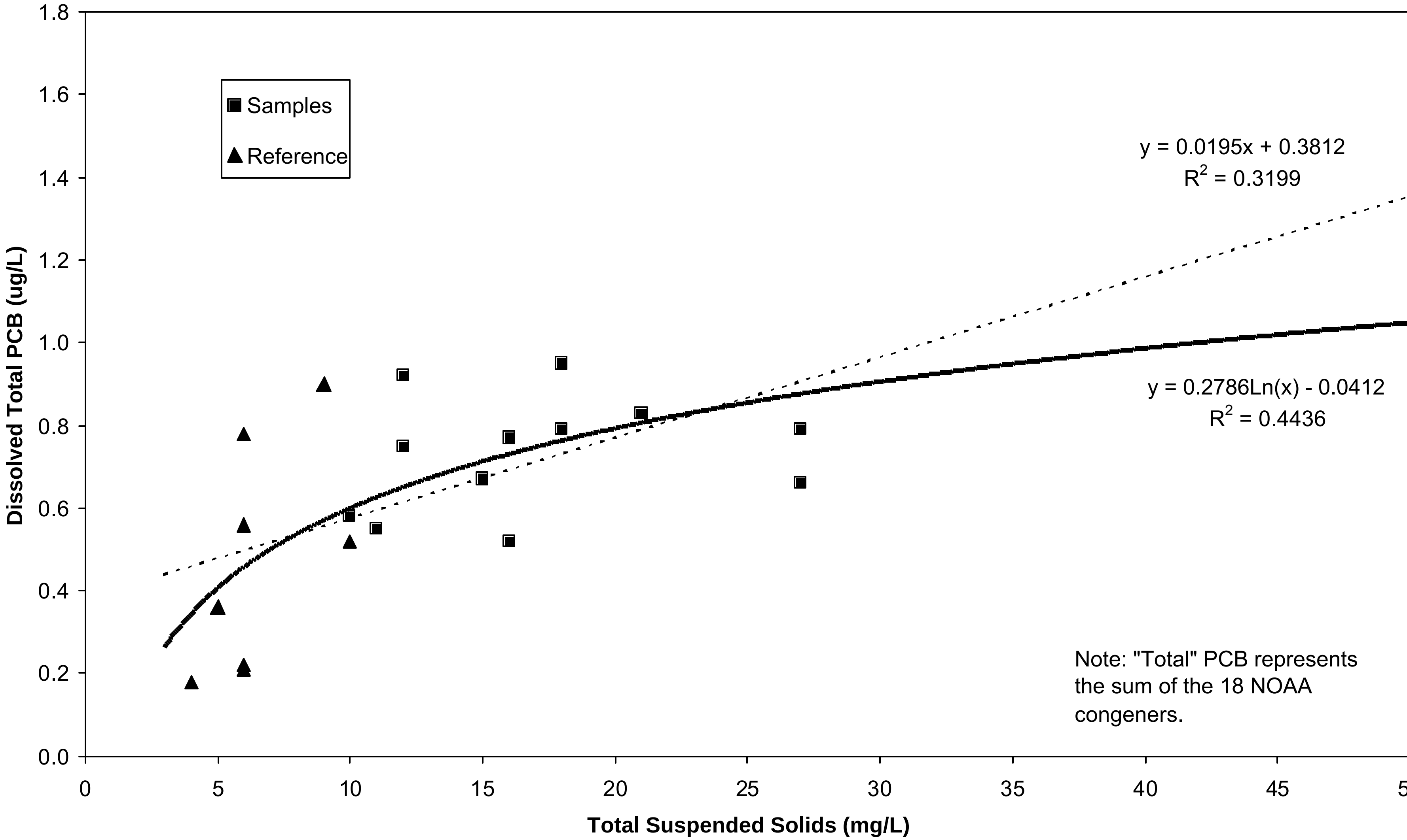


Figure K-29: Correlation between Total Suspended Solids and Total Dissolved PCB

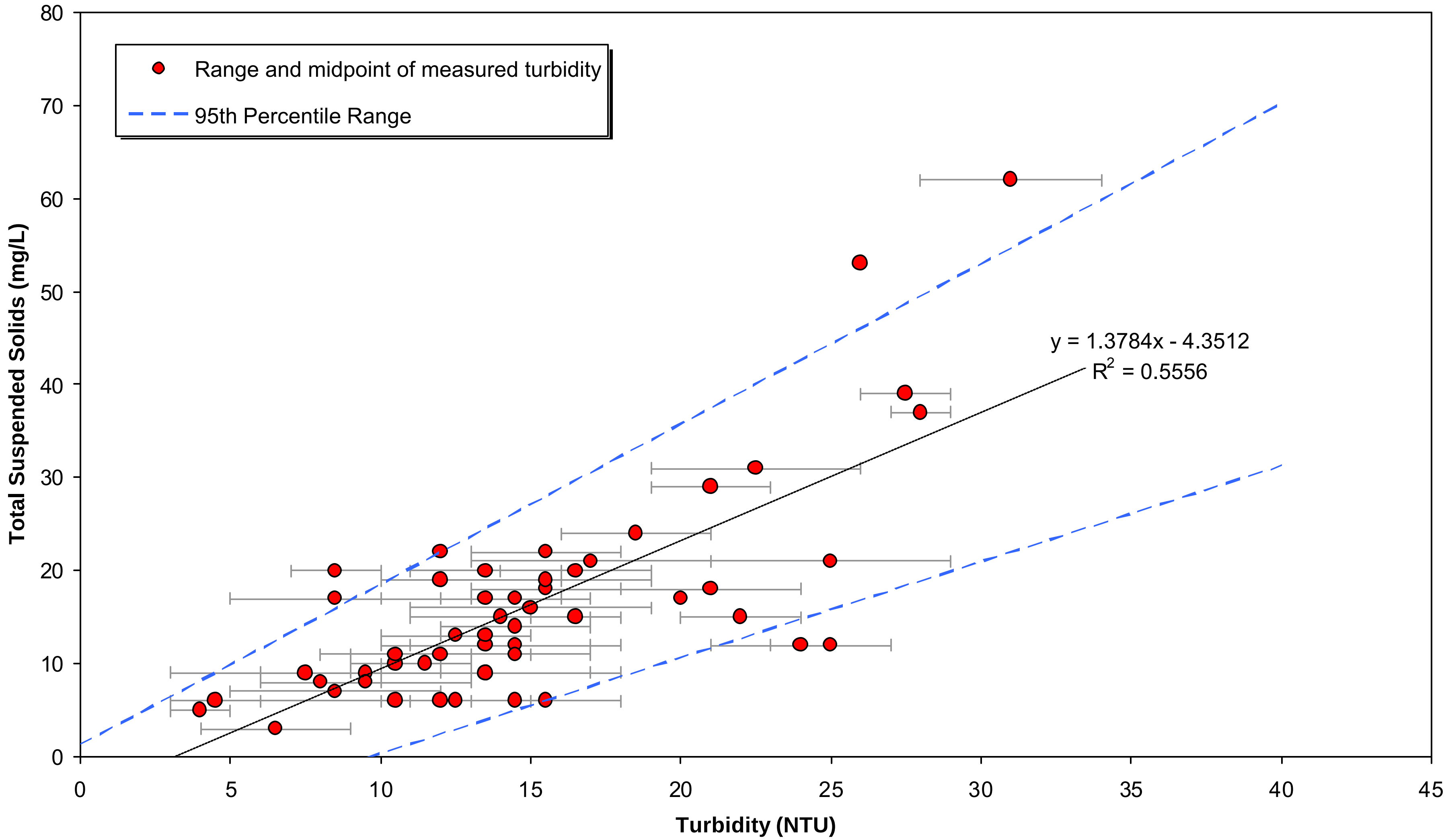


Figure K-30: Correlation between Turbidity (field) and Total Suspended Solids (Lab)

Click here to go to Appendix L